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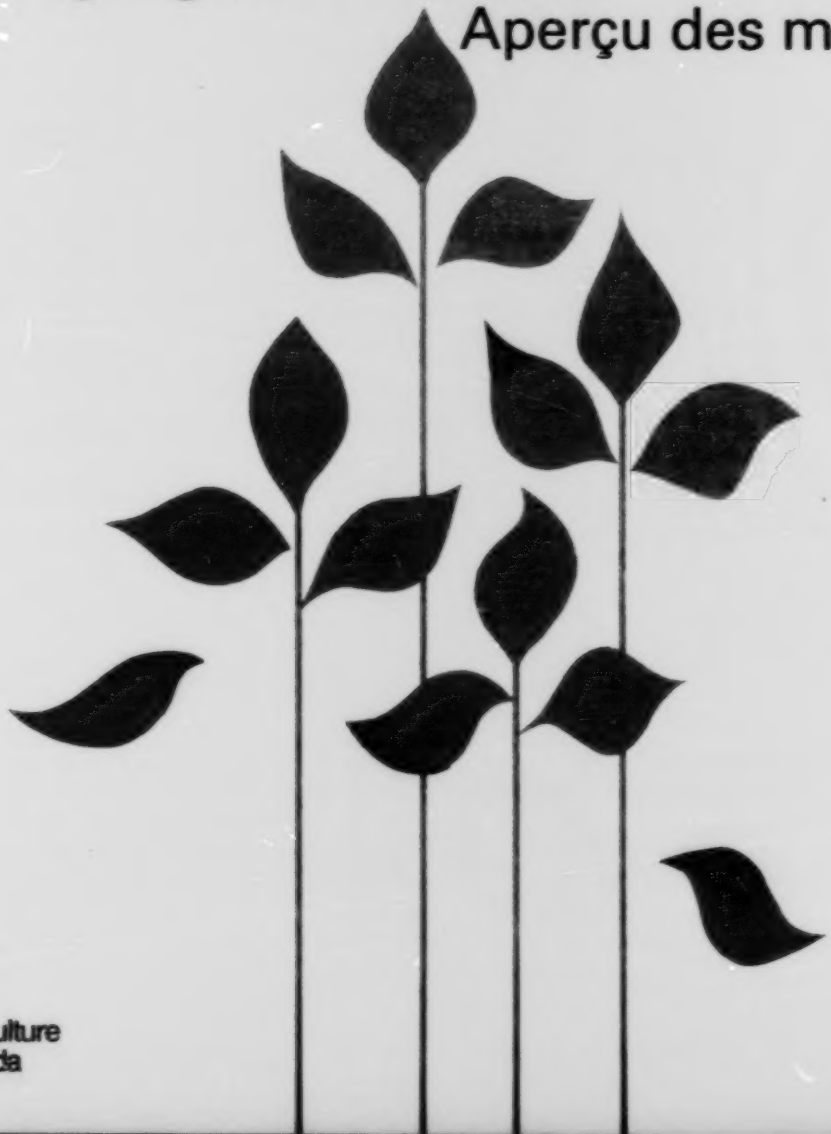

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The *Canadian Plant Disease Survey* is a periodical of information and record on the occurrence and severity of plant diseases in Canada and on the assessment of losses from disease. Other original information such as the development of methods of investigation and control, including the evaluation of new materials, will also be accepted. Review papers and compilations of practical value to plant pathologists will be included from time to time.

L'inventaire des maladies des plantes au Canada est un périodique d'information sur la fréquence des maladies des plantes au Canada, leur gravité, et les pertes qu'elles occasionnent. La rédaction accepte d'autres communications originales notamment sur la mise au point de nouvelles méthodes d'enquête et de lutte ainsi que sur l'évaluation des nouveaux produits. De temps à autre, il inclut des revues et des synthèses de rapports d'intérêt immédiat pour les phytopathologistes.

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FOREWORD

This issue of the Canadian Plant Disease Survey includes a compilation of plant disease survey results for the 1990 crop year. This is the fourth year the Canadian Phytopathological Society and Research Program Service, Research Branch, Agriculture Canada have undertaken this co-operative project.

The Society recognizes the continuing need for publication of plant disease surveys which benefit both Federal and Provincial agencies in planning appropriate research for the control of plant diseases. These surveys become an intrinsic part of the literature of plant pathology in Canada.

The publication of this report depends upon voluntary contributions by Canadian plant pathologists and the collation of the survey results by experts familiar with the diseases of the major crop categories. The survey is published annually in the spring issue of "Canadian Plant Disease Survey". To meet publication deadlines all the results are due to the collators by the first of December. Instructions for submissions and forms are available from the collators. The list of collators is appended.

We wish to thank the contributors and collators who devoted their time to the production of this publication, and look forward to future contributions.

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Canadian Plant Disease Survey Compilers

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AVANT-PROPOS

Ce numéro de l'Inventaire des maladies des plantes au Canada contient les résultats compilés d'études effectuées sur les maladies des plantes pour la campagne agricole de 1990. C'est la quatrième année d'un projet entrepris par la Société canadienne de phytopathologie et le Service aux programmes de recherche de la Direction générale de la recherche d'Agriculture Canada.

La Société reconnaît la nécessité de publier ces résultats sur lesquels s'appuient les organismes fédéraux et provinciaux pour planifier les travaux de recherche qui s'imposent pour lutter contre les maladies des plantes. De plus, ces études viennent enrichir incontestablement la documentation sur la pathologie des plantes au Canada.

La publication de ces rapports est réalisable grâce à la contribution bénévole de phytopathologistes canadiens et au collationnement de leurs résultats par des spécialistes des maladies des grandes cultures. On trouvera en annexe la liste des analystes faisant le collationnement. Comme la publication des résultats se fait chaque année dans le numéro du printemps de l'Inventaire des maladies des plantes au Canada, les rapports doivent être remis aux analystes avant le 1er décembre. On peut s'adresser à eux pour obtenir les formulaires et la marche à suivre pour présenter ces rapports.

Nous tenons à remercier tous les contributeurs et analystes, qui ont consacré une grande partie de leur temps à la production de cette publication annuelle des résultats des études sur les maladies des plantes et espérons vous compter de nouveau parmi nos collaborateurs.

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Nationale Coordonnateur

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Compilateurs

Incidence and severity of verticillium wilt of alfalfa in Prince Edward Island (1988-89) and New Brunswick (1988)

R.A. Martin[1], P. Boswall[2] and K. Lynch[3]

In 1988, verticillium wilt of alfalfa was diagnosed on 12 farms in New Brunswick. A survey on Prince Edward Island in the same year found that 20% of alfalfa fields surveyed had some symptoms of verticillium wilt with approximately 5% of the fields severely infested. No severely infested fields were found on P.E.I. in 1989, although approximately 15% of sampled fields were found to be suffering from verticillium wilt. There was circumstantial evidence from the survey data to indicate that the pathogen responsible for verticillium wilt of alfalfa, *Verticillium albo-atrum*, was introduced by seed at various locations in the two provinces, possibly in 1984.

Can. Plant Dis. Surv. 71:1, 5-7, 1991.

En 1988, on a identifié des cas de flétrissure verticilienne de la luzerne dans 12 fermes du Nouveau-Brunswick. Une enquête effectuée dans l'Île-du-Prince-Édouard la même année a révélé que 20 % des luzernières échantillonnées montraient quelques symptômes de flétrissure et qu'environ 5 % étaient gravement atteintes. On n'a pas rencontré de luzernières gravement infectées dans l'Île-du-Prince-Édouard en 1989, même si environ 15 % des champs échantillonnés se sont avérés atteints par la flétrissure. Il semblerait, d'après les données d'enquêtes, que l'agent pathogène responsable de la flétrissure verticilienne de la luzerne, *Verticillium albo-atrum*, ait été introduit par la semence à divers endroits dans les deux provinces, peut-être en 1984.

Introduction

Verticillium wilt of alfalfa (*Medicago sativa* L.), as incited by *Verticillium albo-atrum* Reinke & Berthold, was first identified in North America in Quebec in 1962, although it did not become established at that time (3). The next report of its occurrence in North America was in 1976, from the north western United States (4). In 1977, verticillium wilt was found again in Canada in south central British Columbia (9). Since its detection in the United States and Canada it has spread rapidly and has been reported in New York State, in 1981 (5) and by 1983 in Alberta, Saskatchewan, Ontario and Nova Scotia (1,2). In 1986, verticillium wilt again was identified in scattered locations in Quebec (7,8).

Until 1988, verticillium wilt had not been identified in either New Brunswick or Prince Edward Island. In late 1988, alfalfa fields in each province were identified as being positive for verticillium wilt. The current study was undertaken to determine the incidence and severity of verticillium wilt of alfalfa in the two provinces.

Materials and methods

New Brunswick (1988): A total of 150 alfalfa fields were assessed for the presence of field symptoms of verticillium wilt. Fields were surveyed from August through to October and classified into one of the following three groups: (1) not having sufficient regrowth for symptom expression, (2) not having suspect plants present, or (3) having chlorotic plants displaying symptoms of verticillium wilt. Lower stem samples from plants from suspect fields were randomly collected for laboratory confirmation.

Stem sections 1.5 cm long from the base of the plants were dipped in 95% ethanol and surface sterilized in 0.5% sodium hypochlorite for three minutes. Sections were rinsed in sterile water, aseptically split lengthwise and placed cut surface upwards on potato dextrose agar (PDA). Approximately 40 stem pieces, representing 20 plants, were evaluated for verticillium infection from each of the suspect fields. Plated stem sections were maintained under U.V. light, 12 hour photoperiod, and periodically examined for the presence of *Verticillium*. Sub-cultures were transferred to water agar for *V. albo-atrum* identification.

Prince Edward Island (1988): After the initial identification of a verticillium wilt infected alfalfa on Prince Edward Island, a survey was initiated on alfalfa fields across the province. The survey was conducted during September and October in 58 randomly selected fields. Each field was inspected for plants showing symptoms of verticillium wilt by walking the entire field in an "W" pattern, usually twice by two different people. Each field was assessed for verticillium wilt based on symptom expression. Fields were rated as not infected, slight infection, moderate infection (10-20% of plants showing symptoms), or severely infected. Plants from all moderately and severely infected fields were collected for laboratory confirmation of *V. albo-atrum* infection.

Prince Edward Island (1989): Two separate samplings were used in the survey of Prince Edward Island fields in 1989. The first samples were collected in late May and

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early June from a total of 90 fields. The second samples were collected from 60 fields in early August just prior to the second cut of alfalfa. In each field 100 lower stem cuttings were taken randomly while walking a "W" pattern through the field.

Stem sections collected in each field were observed for sporulation by *V. albo-atrum* in the laboratory. A 1 cm long section was cut from each stem and split longitudinally. The sections were surface sterilized for ten minutes in 20% Javex® (6% sodium hypochlorite), containing 0.01% Tween 20, rinsed in distilled water and plated on water agar containing 125 ppm chlortetracycline and 125 ppm dihydrostreptomycin sulphate. Plates were then incubated at room temperature for 3 to 4 days and examined microscopically for the presence of *Verticillium*. Sub-cultures of *Verticillium* were plated on PDA for confirming identification.

Results

In New Brunswick samples from a total of 92 fields from 47 different farms were examined in the laboratory for *V. albo-atrum*. Based on plant symptoms and laboratory identification verticillium wilt was confirmed for fields of 12 of the 47 farms with another 9 farms being suspect (Fig. 1). Cultivars in 45 *Verticillium* infested fields were Iroquois (35.5%), Apica (15.5%) and Minto (13.3%) with the remaining 35.5% being other cultivars, an unknown cultivar or mixed plantings. Infested fields were evenly distributed between plantings made from 1983 to 1988 and scattered throughout the alfalfa growing region.

Fig. 1. Distribution of verticillium wilt of alfalfa in New Brunswick in 1988. ●farms with verticillium wilt, ○farms suspected as having verticillium wilt.

Approximately 30% of the fields surveyed in New Brunswick were positive for *V. albo-atrum* infestation, however, the actual level may have been higher given that only fields showing characteristic verticillium wilt symptoms were sampled for laboratory comfirmation. The number of fields with *V. albo-atrum* infested plants may have been higher if plants were symptomless, or had insufficient regrowth after cutting to identify disease symptoms.

Plants in eleven of the 56 fields surveyed in Prince Edward Island in 1988 demonstrated symptoms of verticillium wilt (Fig. 2). Of these fields, three were severely infested and one was moderately infested, with symptoms spread uniformly across the fields. The infections in the remaining positive fields were restricted to isolated plants. Infested fields were at least three years old and the most common cultivars were Apica and Iroquois.

Fig. 2. Distribution of verticillium wilt of alfalfa on Prince Edward Island in 1988. ▲alfalfa fields surveyed but without verticillium wilt symptoms, △fields with occasional infect plant, ◇fields moderately infested (10-20% of plants) and ◆fields severely infested (50% of plants infested).

Fig. 3. Distribution of verticillium wilt of alfalfa on Prince Edward Island in 1989. ▲farms surveyed but no infested alfalfa fields, ◆farms surveyed with fields positive for verticillium wilt and alfalfa ◇fields positive for verticillium wilt but not part of main survey.

Eighteen farms were sampled on Prince Edward Island in 1989 and alfalfa fields on 5 farms were identified as positive for verticillium wilt (Fig. 3). Two fields from one farm were identified as being positive for verticillium wilt during the first of the two sample periods in 1989. A second sample indicated that two other fields on the same farm were also positive for verticillium wilt. In addition, four other fields on separate farms, were also identified as being infested by *V. albo-atrum* by the second sampling. In all cases the incidence on each farm was less than 4%. Severity was in general low, with no field exhibiting infestation levels to match 1988, when some fields had nearly 100% of the plants showing symptoms. In two fields, approximately 10% of plants showed symptoms, while in the remaining fields symptom expression was confined to less that 5% of plants. Two fields showed symptoms in the field but there was no confirmation of *Verticillium* spp. infection in the laboratory. All fields which were positive for *Verticillium* spp. in the laboratory showed verticillium wilt symptoms in the field. In each case where stem section platings were positive for *Verticillium* infection the age of the alfalfa stand was five years or older. One three year old stand had symptoms but no positive identification from plating. This field was adjacent to an older contaminated field and both were managed by the same grower.

There was *Verticillium* infestation at moderate to trace levels in other fields in 1989, which were not part of the 1989 general survey. One of these was the most severely infested field found in 1988. In this field, disease progress had been rapid (6) and plant survival during the winter of 1988-89 was very poor with approximately 10% or less surviving the winter.

Discussion

The survey indicated that verticillium wilt of alfalfa is firmly established in both New Brunswick and Prince Edward Island. While the origin of the primary infection is unknown, the disease pattern in the severely infested fields and the wide geographic distribution of verticillium wilt in the two provinces indicates that the initial introduction into the region was probably from contaminated seed. A number of the fields did exhibit infection patterns which indicated that the introduction of the pathogen was via contaminated farm equipment or movement of contaminated plant residue.

The geographic distribution of the disease in New Brunswick and Prince Edward Island, makes it unlikely that the disease can be eradicated. While some containment may be possible the methods of pathogen spread between fields is such that this would likely not prevent further infestations but only reduce its rate of progression through New Brunswick and Prince Edward Island. The identification of cultivars which are resistant to verticillium wilt and adapted to the Atlantic Region was not in the past a regional priority. Greater emphasis is now being placed on the selection of regionally adapted and verticillium wilt resistant cultivars to minimize the impact of the disease.

Literature cited

1. Atkinson, T.G. 1981. Verticillium wilt of alfalfa: challenge and opportunity. Can. J. Plant Path. 3:266-272.
2. Atkinson, T.G., M.R. Hanna, A.M. Harvey, R.J. Howard, H.C. Huang, J.P. Miska, J.W. Sheppard and J.M. Yorston. 1983. Verticillium wilt of alfalfa. Agriculture Canada, Research Branch, Ottawa. 24 pp. (Revised contribution 1982-8E).
3. Aube, C. and W.E. Sackston. 1964. Verticillium wilt of forage legumes in Canada. Can. J. Plant Sci. 44:427-432.
4. Graham, J.H., R.N. Peaden and D.W. Evans. 1977. Verticillium wilt of alfalfa found in the United States. Plant Dis. Rep. 61:337-340.
5. Kalb, D.W. and R.L. Millar. 1986. Dispersal of *Verticillium albo-atrum* by the fungus gnat (*Bradysia impatiens*). Plant Dis. 70:752-753.
6. Martin, R.A. and P. Boswall. 1989. First occurrence report of verticillium wilt of alfalfa on Prince Edward Island. Can. Plant Dis. Surv. 69:51.
7. Nicholls, H., C. Richard and J.-G. Martin. 1987. Verticillium wilt of alfalfa in Quebec. Can. Plant Dis. Surv. 67:17-20.
8. Richard, C. and H. Nicholls. 1988. Survey of verticillium wilt of alfalfa in Quebec, 1986-87. Can. Plant Dis. Surv. 68:72-73.
9. Sheppard, J.W. 1979. Verticillium wilt, a potentially dangerous disease of alfalfa in Canada. Can. Plant Dis. Surv. 59:60.

Response of cultivars and breeding lines to the disease complex of fusarium wilt and root rot of green peas in southwestern Ontario

J.C. Tu[1]

Each year from 1984 to 1987, between 150 and 200 commercial cultivars and breeding lines of green pea were tested for specific resistance to fusarium wilt (*Fusarium oxysporum* Schlecht. f. sp. *pisi* Snyd. & Hans.) and non-specific resistance to fusarium root rot (*F. solani* (Mart.) Appel & Wr. f. sp. *pisi* (F.R. Jones) Snyd. & Hans.), in a field severely infested with these fungi. The different degrees of susceptibility and resistance of these cultivars and lines were scored and presented herewith.

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Chaque année de 1984 à 1987, on a procédé à des essais de 150 à 200 cultivars commerciaux et lignées généalogiques de petits pois pour évaluer leur résistance spécifique à la flétrissure fusarienne (*F. oxysporum* Schlecht. f. sp. *pisi* Snyd. et Hans.) et non spécifique au pourridié fusarien (*F. solani* (Mart.) Appal et Wr. f. sp. *pisi* (F.R. Jones) Snyd. et Hans.) dans un champ gravement infecté par ces champignons. L'auteur cote et présente les divers degrés de sensibilité et de résistance de ces cultivars et lignées.

Introduction

Root rots were severe constraints to pea production in southwestern Ontario prior to 1984 (McNeil and Howard, 1959; Reyes, 1980). A survey of 550 ha of pea fields in Essex and Kent counties in 1983 and 1984 showed that an average of 26% of the plants had root rot (Tu, 1986, 1987). In the 1983 growing season, a total of 782 fungal cultures were isolated from pea plants from diseased fields. These isolates were identified and categorized. The frequencies of isolation of *F. solani*, *F. oxysporum*, *Aphanomyces euteiches* Drechs. and *Pythium* spp. were 7:4:1:1 (Tu 1987). Disease severity of each root rot was determined on a scale of 0 to 9, where 0 = <10% of root with symptoms, 1 = 10-19%, 2 = 20-29% etc. and 9 = plant dead.

The severity of disease caused by *F. solani* (root rot), *F. oxysporum* (wilt), *Pythium* and *Aphanomyces* averaged 3.2, 8.7, 2.6 and 4.0, respectively. Plants with fusarium wilt usually died, while those with fusarium root rot showed various degrees of stunting and yellowing but rarely died. Pythium and Aphanomyces root rots were observed to be minor problems in peas in Ontario. Based on this information, a disease damage index (DDI) was developed to rank the relative importance of these four root rots. The DDI of a root rot equaled the total amount of root rot (26%) × the frequency of occurrence of each fungus × the severity of disease caused by each fungus. The DDIs for *F. solani*, *F. oxysporum*, *Pythium* spp. and *A. euteiches* were 45, 71, 5 and 8, respectively. Therefore, fusarium wilt was found to be the most damaging disease, followed by fusarium, pythium and aphanomyces root rots, respectively.

The present trial was conducted to test for specific resistance to fusarium wilt (*F. oxysporum* f. sp. *pisi* race 1 and race 2) and non-specific resistance to fusarium root rot (*F. solani* f. sp. *pisi*) in a heavily infested field.

Materials and methods

A field with severe root rot infestation, having a typical disease ratio of fusarium wilt to fusarium root rot of approximately 7:4, was selected for testing cultivars and breeding lines for disease resistance. The test site was located in a field near the town of Tecumseh, on Brookston clay, a fine textured soil classed as an Orthic Humic Gleysol, one of the most widely distributed soil types in southwestern Ontario. This type of soil has poor drainage and is easily compacted (Bolton *et al.* 1982) which predisposes plants to root rots. The majority of peas in southwestern Ontario have been planted in this type of soil.

Cultivars and breeding lines were tested for specific resistance to fusarium wilt and non-specific resistance to *Fusarium solani* every year for a period of 4 years from 1984 to 1987.

Cultivars of peas were obtained from various research organizations, seed companies and processors. Each year, between 150 and 200 cultivars and lines were tested in 4 replications, each with randomized single rows and each grown on naturally infested soil. Root rot severity was rated on a 0-9 scale in the last week of June, with 20 plants examined in each row.

Results and discussion

The results (Tables 1 and 2) showed that many commercial cultivars and breeding lines had a disease severity rating of 0 to 4 indicating a high to moderate resistance to the disease complex of fusarium wilt and root rot in Ontario.

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Table 1. Response of cultivars to the disease complex of fusarium wilt and root rot of peas in southwestern Ontario.†

Root rot severity Index‡ (0-9 scale)	Cultivar*							
0-1.0	Perfection WR[1]							
1.1-2.0	Parlay[2]	Early Perfection[2]	RS-7[3,4]	Green Giant 531	(Nuttall selection)[1]			
2.1-3.0	New Season[2]	Anoka[2]	Novella[2]	Almotto[2,4]	Puget[2]	Bolero[5,6]	Medalist[6]	M140[2]
	Early Perfection 3040[2,4]		Home Guard[1]					
3.1-4.0	Frontier[7]	Parlay[8]	Alaska 423[9]	Early Frosty[2]	Mini[2]	SN4[2,4]	Maro[2]	Little Sweetie[11]
	Jade[2]	M-129[1]	Olympia[12]	Mercurio[10]	Massette[10]			
4.1-5.0	Alpha I[13]	Min 375[2]	Alaska[2]	Mars[8]	Frosty[12]	Pomak[2]	M163[13]	Trident[2]
	Pomak[2]	Patriot[11]	Mitzi[14]	New Era[2,4]	Early Snap[11]	Kosta[15,19]	512 GG[16]	Green Arrow[11]
	Dual[2]	Target[8]	Aldot[2]	Lowata[10]	Alsweet af[17]	Legio Novella[10]		70A[2]
5.1-6.0	Midget[13]	Novella II[8]	M410[2,4]	Sun Valley[15]	Kriter[13]	Novella[3,8]	RS-4[3]	Sparkle[16]
	381 GG[16]	Venus[2]	Opal[12]	Early Sweet II[2]		Salvo[3]	Rally[5,6,8]	Scout[2]
	Signet[2]	451 GG[16]	Abador[8,15]	Dryad[2]	313 GG[16]	Viking[2]	Progress #9[11]	
	Early Perfection 8221[7]		Variegated Little Marvel[9]		Dark Skinned Perfection[2,4]			
6.1-7.0	Tilma[2]	Ronds[11]	Trend[7]	Knight[11]	Dawn[8]	Canada[15,19]	Bountiful[2]	Early Sweet[18]
	235 GG[16]	Spring[2]	Banquet[2]	Greater Progress[11]				
7.1-8.0	Early Sweet 7[2]	Spring[8]	RS-4(Parent)[4]	Improved Laxton Progress[11]				

† This list may include some private cultivars and lines. Interested parties wishing to obtain seeds should write directly to their respective sources.

‡ Based on a 0-9 scale, where 0 = < 10%, 1 = 10-19% of root with symptoms, 2 = 20-29% ... and 9 = plant dead. Thus, a score of 0 to 4.0 is considered to have high to moderate levels of resistance and a score of 4.0 to 9.0 to have moderate to high levels of susceptibility.

* The superscripts following each cultivar indicate the suppliers of seeds: 1, Mr. V.W. Nuttall (deceased), Harrow Research Station, Ontario; 2, Dr. Howard, Alberta Horticultural Research Centre, Brooks; 3, Dr. Reiling, Pillsbury Co. Le Sueur, MN.; 4, Dr. Kraft, Irrigated Agriculture Research and Extension Center (IAREC), WN.; 5, Libby Co., Ontario; 6, Asgrow Seed Co., MI; 7, Canadian Canners Ltd., Ontario; 8, Roger Bros. Seed Co., Ontario; 9, Dr. Reyes, Vineland Research Station, Ontario; 10, Del Monte, CA; 11, Stokes Seeds Ltd., Ontario; 12, Harris Moran Co. Seed, Ontario; 13, Campbell Soup Co., Ontario; 14, Gallatin Valley Seed Co., Ontario; 15, Ornstead Food Ltd., Ontario; 16, Pillsbury Canada, Ontario; 17, Canners Seed Co. ID; 18, Columbia Seed Co., Alberta; 19, Crites Moscow Growers' Inc., ID.

Table 2. Response of breeding lines to the disease complex of fusarium wilt and root rot of peas in southwestern Ontario.†

Root rot severity Index‡ (0-9 scale)	Line*						
1.1-2.0	9602-10[a]	97067-1-5-1[a]					
2.1-3.0	80-717[c,d] 9601-3-7-2[a] 7601-2-1-4[a]	7710-4-1-2[a] 9816-14[a] X9725-8[a]	9731-3[a] 8221-5[a] X9504-2-3[a]	X9602-7[a] 9601-3-3[a] 74-SN5[b]	494-A11[b,c] C82-409[e] WSU R22[b,c]	7801-10-3[a] 9713-6-1[a] Minnesota 108[b,c,d]	X9500-1-1[a] 9713-30[a]
3.1-4.0	7705-7[a] 83-1356[f] WR 1158[f] 507-8[a]	X9727-10[a] 7712-10[a] X9726-2[a] 9716-1-1[a]	X9602-2[a] P.I.189171[b,c] 89171[b] OH69.22[g]	VR1492-1[b,c] 9406-1[a] 9889-2[a] 8615-3EP[a]	508-7[a] 9728-8[a] 9888[a] 74-SN4[b,c]	9603-10-12[a] 83-1392[f] PH14-119[b]	89617-EP[a] 7025[a] 7705-8[a]
4.1-5.0	79-2022[b,c] OH69.07[g] 9766-1[a] WR-1167[f]	9713-8[a] 7705-32[a] C80-211[e] 9728-2[a]	9220[a] P.I.242028[b,c] X9713-19[a] 7705-4[a]	9763-15[a] 776[h] 7705-11[a] 80-933[c,d]	9601-1-1[a] 512-2[a] 378A-3-G[d] C80-212[e]	77EP[a] X9713-9[a] 7705-39[a] 9220[a]	9731-4[a] 79-2024[d] PH91-3[b] FR 79152[e]
5.1-6.0	378A-3-W[d] OH69.08[g] PH-14-119[f]	X9713-8-1[a] 9716-1-2[a] P.I.140295[b,c]	C80-210[e] 74-1492-1[b,c] 80-1313[c,d]	517-2-4[a] 80-1077[c,d] 83-1163[f]	X9724-10[a] 9901[a] P.I.140165[b,c]	508-4-2-4[a] 44ES[a] 3702 Alaska-1[a]	C82-407[e] RR-1178[f]
6.1-7.0	8615-3[a]	P.I.257593[b,c]	2213-E-S[a]	9713-9-2[a]	WSU 23[b,d]		

† This list includes some numbered cultivars, private breeding lines and P.I. accessions. Interested parties wishing to obtain seeds should write directly to their respective sources.

‡ Based on a 0-9 scale, where 0 = < 10%, 1 = 10-19% of root with symptoms, 2 = 20-29% ... and 9 = plant dead. Thus, a score of 0 to 4.0 is considered to have high to moderate levels of resistance and a score of 4.0 to 9.0 to have moderate to high levels of susceptibility.

* The superscripts following each line indicate the suppliers of seeds: a, Dr. Polson, Canners Seed Co., ID; b, Dr. Howard, Horticultural Research Centre, Alberta; c, Dr. Kraft, Irrigated Agriculture Research and Extension Center (IAREC), WN.; d, Pillsbury Co. Le Sueur, MN.; e, Roger Bros. Seed Co., Ontario; f, U.S.D.A., Beltsville, MD.; g, Mr. V.W. Nuttall (deceased), Harrow Research Station, Ontario; h, Libby Food Co., Ontario.

These resistant cultivars (Table 1) could be adopted readily into commercial production in southwestern Ontario. Many of the resistant breeding lines (Table 2) could be developed into new cultivars by breeders or employed as resistant sources for breeding for disease resistance.

Unfortunately, few of these resistant cultivars (Table 1) had been grown in southwestern Ontario prior to 1984 when peas were severely affected by fusarium wilt and root rot, because the etiology of the disease complex was not fully understood.

In 1984, a pea root rot study resolved the etiology of the disease complex (Tu, 1987). Subsequently, a field that exhibited a typical infestation was selected for testing cultivars and breeding lines for specific resistance to *F. oxysporum* f. sp. *pisi* race 1 and race 2 and non-specific resistance to *F. solani* f. sp. *pisi*. Although some pathotypes of *F. solani* f. sp. *pisi* have been reported (Bolton *et al.* 1970), it is felt that the species is not yet highly specialized.

The present results should be helpful to growers, breeders and seed companies, as well as the pea industry at large.

Acknowledgement

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Literature cited

1. Bolton, A.T., A.G. Donaldson and V.M. Nuttall. 1970. Variation in isolates of *Fusarium solani* f. *pisi* collected from processing peas in Ontario. Can. Plant Dis. Surv. 50:108-109.
2. Bolton, E.F., V.A. Dirks and M.M. McDonnell. 1982. The effect of drainage rotation and fertilizer on corn yield. Plant height, leaf nutrient composition and physical properties of Brookston clay soil in southwestern Ontario. Can. J. Soil Sci. 62:297-309.
3. McNeil, B.H. and H. Howard. 1959. Near-wilt of peas in Ontario. Can. J. Plant Sci. 39:483-490.
4. Reyes, A.A. 1980. Pea root rot development and associated fungal pathogens in Ontario fields. Plant Dis. 64:392-393.
5. Tu, J.C. 1986. Incidence and etiology of pea root rots in southwestern Ontario. Can. Plant Dis. Surv. 66:35-36.
6. Tu, J.C. 1987. Integrated control of the pea root rot disease complex in Ontario. Plant Dis. 71:8-13.

Root lesion and root-knot nematodes associated with crops grown in rotation with carrots on Prince Edward Island

J. Diamond[1], J. Kimpinski[2] and C.E. Gallant[2]

Population levels of root lesion nematodes (primarily *Pratylenchus penetrans*) and northern root-knot nematodes (*Meloidogyne hapla*) were examined in crops that precede or are grown in rotation with carrots on Prince Edward Island. Root lesion nematodes were most prevalent in red clover, hay (red clover-timothy mixture) and potato fields. The largest populations of northern root-knot nematodes were found in carrot fields. The effect of *P. penetrans* on carrots grown on Prince Edward Island has not been investigated, but *M. hapla* can be a serious problem and continuous cultivation of carrots should be avoided. In addition, crops such as barley, wheat, or annual ryegrass, that are not hosts for *M. hapla*, should be included in the rotation.

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On a examiné des populations de nématodes radicicoles (essentiellement *Pratylenchus penetrans*) et de nématodes cécidogènes (*Meloidogyne hapla*) dans des cultures qui précèdent ou sont utilisées en rotation avec les carottes dans l'Île-du-Prince-Édouard. Les nématodes radicicoles dominent dans les champs de trèfle rouge, de foin (mélange de trèfle rouge et de fléole) et de pommes de terre. Les populations les plus nombreuses de nématodes cécidogènes se rencontrent dans les champs de carottes. On n'a pas étudié l'effet de *P. penetrans* sur les carottes cultivées dans l'Île-du-Prince-Édouard, mais *M. hapla* peut poser un problème grave de sorte qu'il faut éviter la culture continue. En outre, on devrait inclure dans la rotation des cultures comme l'orge, le blé ou l'ivraie multiflore qui ne constituent pas des hôtes pour *M. hapla*.

Introduction

Both the root lesion nematode, *Pratylenchus penetrans* (Cobb) and the northern root-knot nematode, *Meloidogyne hapla* Chitwood, have been associated with damage to carrots (*Daucus carota* L.) in eastern Canada (8,9). Carrots in particular, are very susceptible to the northern root-knot nematode (4). On Prince Edward Island, injury to carrots by *P. penetrans* or *M. hapla* has not been prevalent. However, during the 1988 growing season, an infestation of *M. hapla* was detected in a carrot field, 12 ha in size, in the western part of the province. The yield loss was estimated to be about 40%, with many carrots exhibiting unmarketable characteristics such as proliferation of fine roots and malformed or fork-shaped tap roots. Two other fields in the same region of the province had signs of minor damage due to *M. hapla*. The cause of the large build up of northern root-knot nematodes in these isolated locations is unknown. However, it has been shown that the previous crop in a sequence can influence nematode population levels and plant yields in the next crop (1). Therefore, we examined population levels of root lesion and northern root-knot nematodes in crops that often precede or are grown in rotation with carrots on Prince Edward Island.

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Materials and methods

Soil and root samples were collected from fields intended for carrot production in the following year. Twenty-four fields were sampled during October-November 1988 and 16 fields were sampled in October 1989. Soil samples for nematode determination were collected as outlined by Gallant (2). Each sample was mixed thoroughly and passed through a screen with 2-mm openings to remove root and other debris. A 50-g sub-sample of soil was placed in a modified Baermann funnel (7), and up to 10 g of fresh roots from each sample were set in a mist chamber (3) at 20-25°C. After 7 days nematodes that had emerged from soil and roots were identified and counted using a stereomicroscope at 70×.

Results and discussion

Pratylenchus spp. was the dominant genus recovered from soil and root samples (Table 1). The majority were *Pratylenchus penetrans* and the remainder were *P. crenatus* Loof. Red clover (*Trifolium pratense* L.), hay, which is usually a mixture of red clover and timothy (*Phleum pratense* L.), and potato (*Solanum tuberosum* L.) harbored large root populations of root lesion nematodes. In Quebec, *Pratylenchus penetrans* has delayed maturity and caused the development of abnormal taproots in carrots (9). To date, on Prince Edward Island, observations in the field have not indicated that root lesion nematodes are a serious problem. The highest numbers of *Meloidogyne hapla* were found in carrot roots. This nematode species was recovered from 42% and 25% of all soil and root samples, respectively in 1988, and from 11% and 22% of the soil and root samples, respectively in 1989

Table 1. Root lesion and northern root-knot nematodes in soil and roots of crops grown in rotation with carrots on Prince Edward Island

Crops	No. of nematodes /kg of soil			No. of nematodes/g of root		
	No. of fields	*P. penetrans*	*M. hapla*	No. of* fields	*P. penetrans*	*M. hapla*
1988						
Barley	1	2550†	0	1	410	0
Cereal§	5	2150 (5)	30 (1)	0		
Carrot	4	2500 (4)	1360 (3)	1	0	18790
Clover#	6	5600 (6)	1000 (4)	2	5640 (2)	0
Hay ‖	1	7100	0	1	27600	0
Ryegrass	1	1240	0	0		
Potato	4	8570 (4)	40 (2)	1	18630	0
Rutabaga	2	2200 (2)	0	2	70 (1)	20 (1)
1989						
Barley	7	470 (6)	60 (1)	6	1650 (6)	0
Cereal	1	1800	0	1	440	0
Carrot	3	1360 (3)	60 (1)	3	3560 (3)	3930 (2)
Clover	2	5400 (2)	0	2	3280 (2)	0
Hay	3	3400 (3)	0	3	6320 (3)	0

* Root samples were not taken from all fields where soil was obtained.

† Arithmetic means include zero values from fields where nematodes were not detected. Parentheses indicate number of fields in which nematodes were found.

§ Mixture of oats and barley; some clover also present.

\# Primarily red clover.

‖ Primarily red clover and timothy.

(average of data from all crops shown in Table 1). These frequencies indicate the potential for economic yield reductions in carrots for the province, since even light infestations by *M. hapla* can cause yield losses (8).

Spiral (*Helicotylenchus* spp.), pin (*Paratylenchus* spp.) and stunt (*Merlinius* spp. and *Tylenchorhynchus* spp.) were recovered from many of the soil samples. The effect of these ectoparasitic nematodes on carrots is not well documented (5), but their impact on yields in the Maritime region appears to be minor.

High populations of root lesion nematodes were recovered from hay or potato crops, and could cause problems in the next carrot crop. Annual ryegrass (*Lolium multiflorum* Lam.) tends to harbor lower numbers of root lesion nematodes than red clover or timothy (6), and could be rotated with carrots if *P. penetrans* were a problem. The information in this survey also indicated that planting carrots two years in a row could increase the probability of damage from *M. hapla*. Avoidance of continuous carrot crops, and inclusion in the rotation of non-hosts for *M. hapla*, such as barley (*Hordeum vulgare* L.), wheat (*Triticum destivum* L.), timothy and annual ryegrass, and elimination of forage legumes would reduce the chances of root-knot nematode damage to carrots. Finally, the prevalence of root lesion and northern root-knot nematodes in fields where carrots were to be cultivated illustrated the need for a diagnostic service that would help growers to avoid fields with high nematode populations.

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Literature cited

1. Arsenault, W.J., J. Kimpinski and J.A. MacLeod. 1989. Root lesion nematodes and flue-cured tobacco yields in a rye-tobacco or soybean-tobacco crop sequence. Tob. Sci. 33:72-73.
2. Gallant, C.E., J. Diamond and J. Kimpinski. 1989. Collection of soil and roots for analysis of plant-parasitic nematodes. Prince Edward Island Department of Agriculture, Agdex No. 628.
3. Hooper, D.J. 1986. Extraction of nematodes from plant material. In: Laboratory methods for work with plant and soil nematodes, pp. 51-58 (ed. by J.F. Southey), H.M.S.O., London.
4. Jensen, H.J. 1972. Nematode pests of vegetables and related crops. In: Economic nematology, pp. 377-408 (ed. by J.M. Webster), Academic Press, London.
5. Johnson, A.W. and G. Fassuliotis. 1984. Nematode parasites of vegetable crops. In: Plant and insect nematodes, pp. 323-372 (ed. by W.R. Nickle), New York, Dekker.
6. Kimpinski, J., H.T. Kunelius and B.N. Craig. 1988. Occurrence of plant parasitic nematodes in forage legumes and grasses. Forage Notes 32:30-32.
7. Townshend, J.L. 1963. A modification and evaluation of the apparatus for the Oostenbrink direct cottonwool filter extraction method. Nematologica 9:106-110.
8. Vrain, T.C. 1978. Dissémination et importance des nématodes phytoparasitic dans les sols organiques du Québec. (Abstr.) Phytoprotection 59:186.
9. Vrain, T.C. and G. Belair. 1981. Symptoms induced by the lesion nematode, *Pratylenchus penetrans* on carrot taproots in organic soils. Phytoprotection 62:79-81.

Occurrence of lettuce rust in Onoway, Alberta in 1989

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Six lettuce fields in Onoway, Alberta were examined from early to late June 1989 for the presence of leaf rust. By the end of June, disease incidence for the fall-seeded cultivars Parris Island and Buttercrunch was 100%, whereas disease incidence of four spring-seeded cultivars was less than 1%. No significant differences in disease incidence were observed among four cultivars seeded in the spring (Parris Island, Buttercrunch, Red Rapids and Grand Rapids). Based on the morphological examination of aeciospores and peridia using scanning electron microscopy, *Puccinia dioicae* Magn. was identified in the lettuce fields.

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On a examiné six champs de laitue à Onoway (Alberta) du début à la fin de juin 1989 pour y déceler la présence de rouille des feuilles. À la fin de juin, le taux de morbidité des cultivars semés à l'automne, Parris Island et Buttercrunch, était de 100 %, alors que celui de quatre cultivars semés au printemps était inférieur à 1 %. On n'a constaté aucune différence significative dans le taux de morbidité de quatre cultivars semés au printemps (Parris Island, Buttercrunch, Red Rapids et Grand Rapids). Grâce à l'examen morphologique des écidiospores et des péridies au moyen de la microscopie électronique, on a pu identifier *Puccinia dioicae* Magn. dans les champs de laitue.

Introduction

Leaf rust of field lettuce (*Lactuca sativa* L.) can be incited by either *Puccinia chondrillae* Corda, an autoecious macrocyclic rust, or *P. dioicae* Magn., a heteroecious microcyclic rust (2, 5). This disease was first recorded at Edmonton, Alberta in 1956 (3), but there have been no subsequent published records of its occurrence in Alberta. Leaf rust of lettuce was recently observed again in a lettuce market garden in Onoway, 60 km northwest of Edmonton. Because very heavy infection was observed in some lettuce cultivars, although others showed little or no infection, studies were undertaken to determine the identity and incidence of leaf rust on different cultivars of field lettuce planted in this garden.

Materials and methods

Six lettuce field plots at one Onoway market garden were examined for the incidence of leaf rust disease. The field site had grown forage grasses for several years and was in summer fallow prior to planting lettuce. No fertilizer was incorporated into the soil because it was full of organic matter. Seeds were hand-sown at a depth of 1 cm and a rate of 0.5 g/m^2. Lettuce cvs. Parris Island and Buttercrunch were sown in the fall of 1988 and the spring of 1989. Lettuce cvs. Grand Rapids and Red Rapids were sown only in the spring of 1989. Fall-seeded plots were 1.5 m × 7.5 m, and spring-seeded plots were 1.5 m × 5.0 m. Each plot was isolated by a 30 cm strip that was kept harrowed throughout the growing season. During the early summer of 1989, the number of plants per plot infected with leaf rust was assessed visually.

The species determination was made by examining morphological characteristics of aecia. Leaf segments with aecia were fixed in 2% glutaraldehyde in 0.1 M cacodylate buffer at pH 7.2 for 16 h, washed in 0.1 M cacodylate buffer, and postfixed in 1% osmium tetroxide in the same buffer for 4 h. The samples were then dehydrated through an ethanol series, critical point dried (using liquid CO_2 as transitional fluid), and affixed to metal stubs with silver paint. The specimens were sputter coated with gold (15 nm thick), examined, and photographed with a Hitachi S510 scanning electron microscope (SEM).

Results and discussion

Whitish-yellow aecia exposing a powdery mass of yellow aeciospores were found in groups of 50-200 on the lower surface of the outer leaves. Each group of aecia was about 1.5 cm across and its presence did not cause hypertrophy of the leaf tissue (Figs. 1 and 2). On the corresponding upper leaf surfaces large yellow spots developed.

SEM observations revealed that the mature aecium was cupulate with nearly globoid aeciospores borne within the confines of the peridium (Fig. 3). The well-developed peridium was one cell layer thick, and it clearly delimited the peripheral boundaries of the aecium. Mature aeciospores were densely ornamented with smooth, knoblike verrucae, except for a circular smooth patch (Fig. 4). Four to five germ pores were located equatorially around the aeciospore. The pores were covered with plugs (Fig. 4). Based on the morphology of aeciospores and peridia, as well as the need of an alternate host to complete its life cycle, only one rust species, *P. dioicae* Magn., was identified in the lettuce fields (2, 5).

Rust pustules were first observed in early June 1989, on the fall-seeded lettuce cvs. Parris Island and Buttercrunch, and the level of infection was very low. By the end of June, a large difference in numbers of infected plants was observed between fall-seeded and spring-seeded plots.

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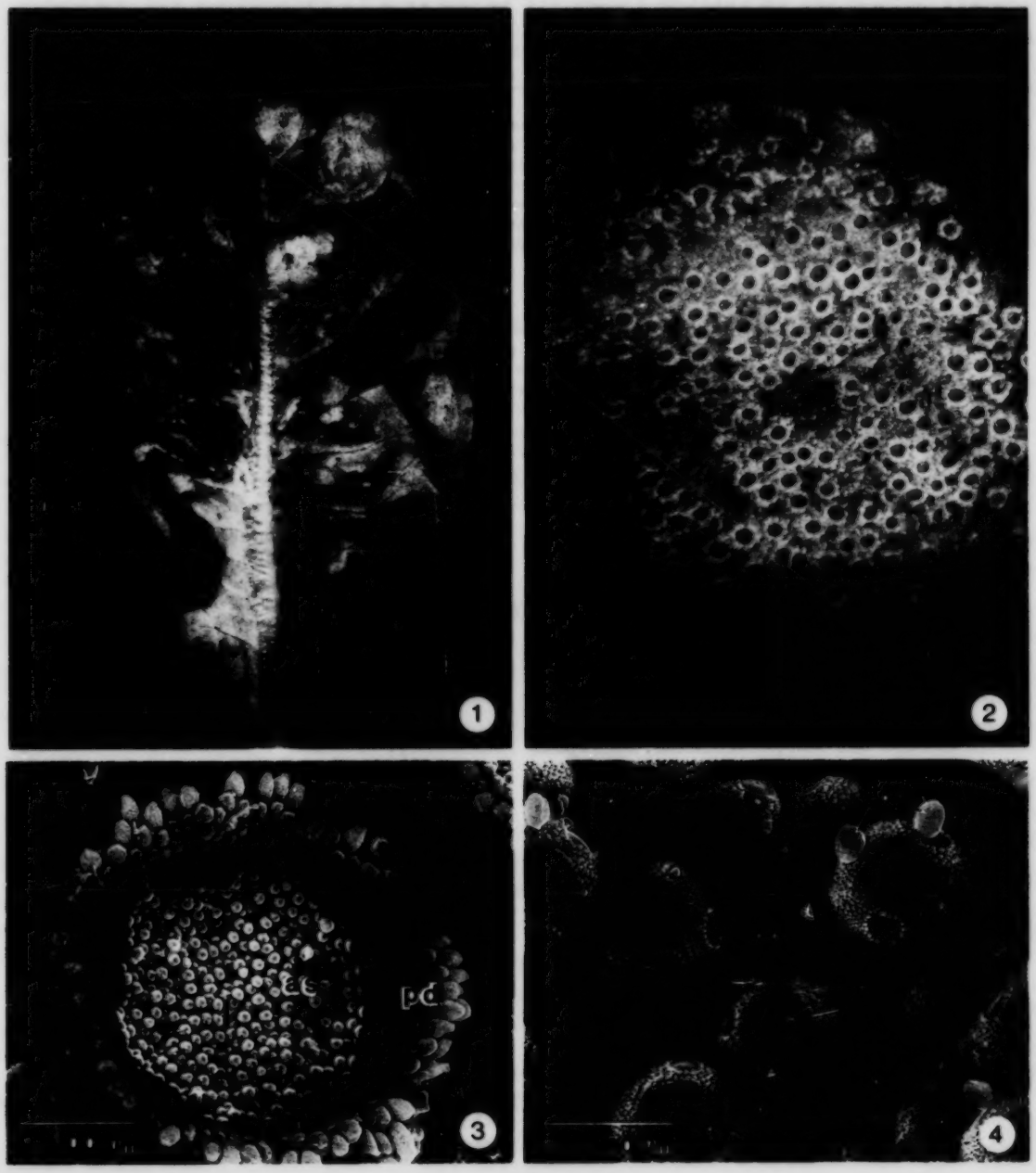

Figs. 1-2. *Puccinia dioicae* on field lettuce (*Lactuca sativa* L.)

Fig. 1. Aecia on the lower leaf surface. × 0.7.

Fig. 2. Group of aecia on the lower leaf surface. × 30.

Figs. 3-4. SEM of aecial state of *Puccinia dioicae*.

Fig. 3. Mature aecium bordered by one cell layer peridium (pd) and hundreds of mature aeciospores (as) within the aecium. × 130.

Fig. 4. Mature aeciospores showing the germ pores (gp) with plugs (p) and with knoblike verrucae (v), except for the circular smooth patches (arrow) free of verrucae. × 2250.

For both cvs. Parris Island and Buttercrunch, fall-seeded plots had the greatest disease incidence of 100%, whereas spring-seeded plots had the least disease incidence at less than 1% (Table 1). No significant differences were observed among the four spring-seeded cultivars (Parris Island, Buttercrunch, Red Rapids and Grand Rapids) in their resistance to leaf rust disease, since the disease incidence of all four was less than 1%.

Table 1. Disease incidence of leaf rust on four different cultivars of field lettuce (*Lactuca sativa L.*).

Cultivar	Time of Seeding*	No. of Plants Sampled	Disease Incidence %
Parris Island	Fall	450	100
	Spring	800	< 1
Buttercrunch	Fall	250	100
	Spring	500	< 1
Red Rapids	Spring	800	< 1
Grand Rapids	Spring	600	< 1

* Seeds planted either in fall of 1988 or spring of 1989. Fall-seeded lettuce reached early maturity with 13 to 15 leaves and spring-seeded lettuce with 5 to 8 leaves.

Our results demonstrate that all fall-seeded lettuce cultivars had disease incidence ratings of 100%, compared to spring-seeded cultivars with ratings less than 1%. Furthermore, the germination rate of fall-seeded lettuce is much lower than that of spring-seeded lettuce because of the reduction of seed viability (1). However, many growers still favor the practice of fall seeding, mainly because this leads to earlier maturity and higher market prices in the following season.

The yield loss of lettuce due to leaf rust has always been considered very negligible in North America (6, 8), simply because rarely more than a few infected leaves were found present in a field. In Europe, however, leaf rust of lettuce can occasionally be very destructive (7). Data from this study indicate that economic losses due to *P. dioicae* can be significant when environmental factors and cultural practices favor its development, and when populations of the alternate host, sedge grass (*Carex muricata* L.), occur nearby for completion of the rust life cycle (4). It is evident, therefore, that yield loss due to infection by lettuce rust may be more significant than generally recognized, and that further study in this aspect is needed to determine the extent of yield loss in lettuce.

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Literature cited

1. Alberta Agriculture. 1989. Alberta vegetable production guide 1989-1990 AGDEX 250/13-1.
2. Cummins, G.B. 1978. Rust fungi on legumes and composites in North America. University of Arizona Press, Tucson.
3. Ginns, J.H. 1986. Compendium of plant disease and decay fungi in Canada 1960-1980. Research Branch, Agriculture Canada Publication 1813.
4. Kern, F.D. 1917. North American species of *Puccinia* on *Carex*. Mycologia 9:205-238.
5. Moore, W.C. 1946. New and interesting plant diseases. Trans. Br. Mycol. Soc. 29:250-258.
6. Rankin, L. 1987. Lettuce disease survey in New Brunswick, 1986. Can. Plant Dis. Surv. 67:25-30.
7. Sherf, A.F. and Macnab, A.A. 1986. Vegetable diseases and their control. 2nd ed. John Wiley and Sons Inc., New York.
8. Sprague, R. 1945. Rust on lettuce in North Dakota. Plant Dis. Reptr. 29:654.

Occurrence of verticillium wilt of alfalfa in southern Alberta, 1980-86

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Surveys from 1980-86 revealed that verticillium wilt, caused by *Verticillium albo-atrum*, was a widespread and often serious disease of alfalfa in southern Alberta. It was found in 156 (10.1%) of 1537 fields surveyed during this period. The disease occurred most frequently in irrigated alfalfa fields used for hay, pasture and dehydrated products. It was rarely observed in seed and dryland fields. The highest incidence and severity of wilt were seen in the Lethbridge-Taber area. The disease was more extensive and destructive in stands four years of age and older. Although it was positively diagnosed for the first time in Alberta in 1980, alfalfa seed assay data suggest that the disease was present in southern Alberta prior to this date. Many producers plowed down wilt-infected alfalfa crops because of stand debilitation and to minimize the risk of disease spread to nearby fields.

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Des enquêtes effectuées de 1980 à 1986 ont révélé que la flétrissure verticilienne causée par *Verticillium albo-atrum* était une maladie répandue et souvent grave de la luzerne dans le sud de l'Alberta. On l'a rencontrée dans 156 (10,1 %) des 1 537 luzernières qui ont fait l'objet des enquêtes au cours de cette période. La maladie se rencontre plus fréquemment dans les luzernières irriguées utilisées pour le foin, la paissance et les produits déshydratés. On l'a rarement observée dans les luzernières de semences et en l'absence d'irrigation. La plus forte fréquence et gravité de la maladie a été observée dans la région de Lethbridge-Taber. La maladie était plus étendue et dévastatrice dans les peuplements âgés d'au moins quatre ans. Même si la maladie a été positivement identifiée pour la première fois en Alberta en 1980, les données sur les essais de semence de luzerne donnent à penser qu'elle était présente dans le sud de l'Alberta avant cette époque. De nombreux producteurs ont labouré et enfoui les cultures de luzerne infectées à cause de la détérioration des peuplements et pour minimiser le risque de propagation de la maladie aux luzernières voisines.

Introduction

During the past decade, verticillium wilt (VW), caused by *Verticillium albo-atrum* Reinke & Berth., became a widespread and economically important disease of alfalfa (*Medicago sativa* L.) in several areas of Canada and the United States (2, 7, 10). Although the first records of VW in North America were from Québec (3) and British Columbia (1), the disease was not confirmed in commercial alfalfa fields in Canada until 1977 (7). Because VW represented a potentially serious threat to Alberta's alfalfa industry (1, 18), a preliminary survey of 124 alfalfa fields across the province was carried out in 1979 (11). Although VW was not found, it was concluded that a more comprehensive annual survey was warranted. As a result, systematic field surveys were carried out through all or part of the province between 1980-88. These activities were coordinated by Alberta Agriculture and involved staff from Alberta Agriculture, Agriculture Canada, Alberta Environment and the University of Alberta. This report describes the results of surveys for VW and other diseases of alfalfa in southern Alberta, the most intensive alfalfa-producing area of the province, from 1980-86. Survey reports for 1987-88 have already been published (14, 16).

Materials and methods

Field Surveys. Approximately 1537 alfalfa fields in southern Alberta were surveyed for VW from 1980-86. A quota of fields was established for each Census Division (CD) (Fig. 1) based on the alfalfa hectarage in these areas. Within each CD, alfalfa fields were selected at random for surveying. The presence of distinctive VW symptoms, such as wilting, V-shaped yellow or pinkish-brown sections on leaf tips and twisting and curling of younger leaves, was taken as evidence that the disease was present. Two types of survey procedure were used. In one, surveyors entered each field at a corner, walked 200 paces toward the center, then exited at 90° to the closest edge of the field. On the exit transect, the number of VW-suspect plants seen within one meter on each side of the line was estimated. In the second type, which also was started at one corner of each field, surveyors walked an M-shaped transect of approximately 800 paces, stopping at 10 equally-spaced spots along the way. At each spot, the number of VW-infected plants in a 1 m area was determined. The type of survey procedure used was left

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to the discretion of individual survey teams. In some instances, the survey procedure was expedited by simply noting the presence or absence of VW-infected plants without estimating disease incidence. If suspect plants were found, samples were taken to a laboratory for confirmation. Surveys were generally carried out in July, August or September, when disease symptoms were the most apparent.

Isolation of *V. albo-atrum*. One cm long pieces were cut from the lower stems of infected plants. These were dipped in 70% ethanol, placed in 1% sodium hypochlorite for three minutes, rinsed in sterile water, split in half longitudinally, and placed onto Czapek's agar amended with 200 ppm of streptomycin or onto Christen's selective medium (4). Isolation plates were incubated at ca. 20°C for 5-7 days in a dark incubator or occasionally under natural or cool-white fluorescent light at room temperature (21-24°C). *V. albo-atrum* was confirmed based on the presence of verticilliate conidiophores with darkened bases on the host tissue, the presence of dark resting mycelium, the absence of microsclerotia and the occurrence of numerous, hyaline, aseptate, ellipsoidal to sub-cylindrical conidia (9).

Pathogenicity Testing. From 1980-82, the pathogenicity of a representative number of *V. albo-atrum* isolates was determined using the root dip technique (19). Alfalfa plants (cv. Anchor) were grown in a greenhouse for at least 8 weeks prior to inoculation. *Verticillium* cultures were grown on Czapek's agar for at least two weeks prior to use. A concentrated conidial suspension (10^6-10^8 condia/mL) was prepared by flooding a 9 cm diameter Petri plate with 10 mL of sterile water, then rubbing the colony surface with a blunt instrument to dislodge the conidia. The trimmed roots of alfalfa seedlings were then swirled and soaked in the conidial suspension for ca. 3 minutes, and the inoculated seeedlings were transplanted into individual pots containing a steam-pasteurized potting medium. The plants were maintained in a greenhouse for 3-5 weeks before examination for wilt symptoms. At least two seedlings were inoculated with each isolate.

Results and discussion

Field Surveys. From 1980-86, 1537 alfalfa fields in southern Alberta were surveyed for VW (Table 1). Of these, 156 (10.1%) had the disease. The majority of surveyed fields were irrigated (1136) and 13.5% of these were infested with VW. Less than 1.0% of the dryland fields examined had the disease. The highest concentration of VW was in CD 2 (Fig. 1). The majority of alfalfa fields in this area were irrigated. Overall, 118 of the 883 irrigated fields (13.4%) surveyed in CD 2 between 1980-86 had the disease. Lesser amounts of VW were found in CD's 1, 3, 5 and 6; none was found in CD 4, a predominantly dryland region.

Fig. 1. Census divisions of southern Alberta.

Verticillium wilt in 1980-81. In 1980, 5 of 73 alfalfa fields in southern Alberta were found to have the disease (Table 1). These infested fields (ca. 120 ha) were irrigated and used for hay production. The average disease incidence ranged from a trace to slight (1-5%). The following year, 22 of 114 fields surveyed (ca. 565 ha) had VW, and disease incidence ranged from a trace to very high (1->50%). The distribution of diseased fields in 1981 extended beyond the area where it had been found in 1980 (Fig. 2). A dramatic increase in the number of diseased fields occurred in the Lethbridge area where, among others, eight dairy farms were found to be infested. All of the VW-infested alfalfa fields were irrigated and used for hay, silage, or pasture. This finding coincided with the observations of Christen and Peaden (5) that VW was primarily a problem on irrigated alfalfa.

VW was found in pure stands of alfalfa as well as in alfalfa-grass mixtures during the 1980-81 surveys. No VW was found in fields used for seed production or dehydrated products. The seed used to plant several of the diseased fields was imported from Washington State where VW was known to occur (7). It appeared likely that VW was introduced to southern Alberta on Washington-grown alfalfa seed infested with *V. albo-atrum* based on this circumstantial evidence and the results of previous seed tests (19). Thor appeared to be the most susceptible of several cultivars examined. The majority of *V. albo-atrum* isolates were pathogenic to alfalfa seedlings in greenhouse tests.

Growers on whose farms VW was found were informed of its presence and given control advice. A key point in the disease management strategy was the recommendation that they attempt to eradicate VW by plowing down infested alfalfa crops. In response to this advice, ca. 80% of the 1980 VW-infested hectarage and 47% of the field area infested in 1981 was plowed by the end of November, 1981.

Table 1. Incidence of verticillium wilt in alfalfa fields in southern Alberta, 1980-86.

Year	Census division	No. of irrigated fields		No. of dryland fields		Total fields	
		Surveyed	With VW	Surveyed	With VW	Surveyed	With VW
1980	1	4	0	2	0	6	0
	2	44	5	7	0	51	5
	3	1	0	11	0	12	0
	4	0	0	4	0	4	0
		49	5	24	0	73	5
1981	1	1	1	0	0	1	1
	2	74	21	19	0	93	21
	3	8	0	4	0	12	0
	4	3	0	5	0	8	0
		86	22	28	0	114	22
1982	1	56	6	17	0	73	6
	2	639	58	39	1	678	59
	3	31	5	50	0	81	5
	4	1	0	27	0	28	0
	5	64	2	36	0	100	2
	6	0	0	78	0	78	0
		791	71	247	1	1038	72
1983	1	5	0	0	0	5	0
	2	32	9	2	0	34	9
	3	7	1	4	0	11	1
	4	1	0	4	0	5	0
	5	7	2	2	0	9	2
	6	4	0	12	0	16	0
		56	12	24	0	80	12
1984	1	4	1	3	0	7	1
	2	37	9	1	0	38	9
	3	7	0	4	0	11	0
	4	0	0	4	0	4	0
	5	5	0	5	0	10	0
	6	4	0	15	0	16	0
		54	10	32	0	86	10
1985	1	6	4	0	0	6	4
	2	16	8	1	0	17	8
	3	8	2	4	0	12	2
	4	1	0	8	0	9	0
	5	3	2	0	0	3	2
	6	1	0	5	2	6	2
		35	16	18	2	53	18
1986	1	8	2	0	0	8	2
	2	41	8	0	0	41	8
	3	7	3	5	0	12	3
	5	9	4	4	0	13	4
	6	0	0	19	0	19	0
		65	17	28	0	93	17
Grand Total		1136	153	401	3	1537	156

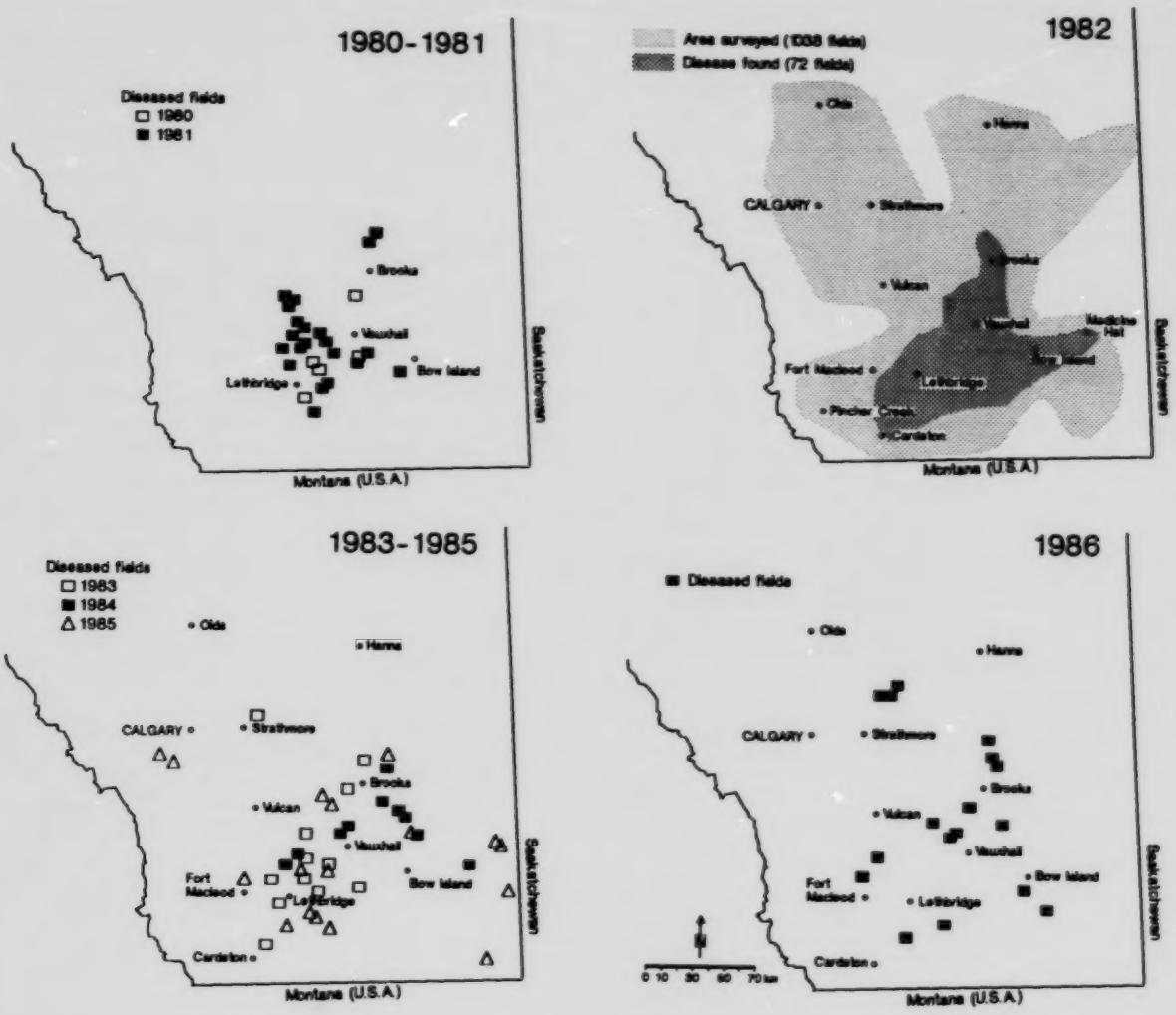

Fig. 2. Distribution of verticillium wilt of alfalfa in southern Alberta from 1980-86.

Verticillium wilt in 1982. The most extensive survey was carried out in 1982 when 1038 fields in southern Alberta were examined (Table 1). The disease was most concentrated in the irrigated districts in CD 2 (Fig. 2), especially in the County of Lethbridge where 41.6% of the fields and 42.5% of the hectarage examined had VW. The disease was largely restricted to fields of irrigated alfalfa grown for hay and dehydrated products. Disease incidence typically ranged from a trace to high (1-35%), but several fields were devastated by the disease (>50% of the plants infected). Only 1 of 247 dryland fields surveyed was infested. No VW was found in any seed fields. All *V. albo-atrum* isolates obtained during the 1982 survey produced typical wilt symptoms when inoculated onto alfalfa seedlings.

Twelve commercial alfalfa cultivars were identified amongst the fields that had VW in 1982 (Table 2). Thor was a constituent, in whole or in part, of at least 21 (29%) of the 72 VW-positive fields. This widely grown cultivar was a favourite amongst hay and dehy producers because of its rapid regrowth after cutting. This characteristic often permitted three cuts per season. The disease was found in stands aged 1 to 25 years, averaging 6.3 years over the 67 infested fields where such data were available. The relatively old age of many of these fields raised the possibility that VW may have been present at low levels for several years or had otherwise gone undetected by the producers until it was identified during this survey.

Table 2. Cultivars and age of stands in alfalfa fields with verticillium wilt in southern Alberta, 1982.

Cultivar*	No. fields with VW	Average age of stands (yr)	Range of stand ages (yr)
Anchor	1	4.0	4
Beaver	8	7.5	4-12
Canada #1	5	3.6	1-5
Chimo	1	10.0	10
Gemini	1	5.0	5
Ladak	1	5.0	5
Thor	10	3.6	2-5
Vernal	6	5.8	4-10
919 Brand	4	6.3	5-8
Mixtures	14	5.4	3-15
Unknown	21	8.6	3-25
	72 avg. =	6.3	

* The nine named cultivars were pure stands. Mixtures: Anchor (1), Beaver (3), Canada #1 (2), Grimm (1), Ladak (1), Rambler (1), Thor (11), Trek (1), Vernal (2), and 919 Brand (5); figures in parenthesis represent the number of fields containing that cultivar where mixed stands occurred. Unknown: producers had no record of the cultivar(s) planted.

Machinery usage may have been a factor in the spread of VW in southern Alberta. At least 20 of the 72 producers with VW-positive fields reported that machinery other than their own was used to harvest their alfalfa crops (Table 3). Significant amounts of diseased alfalfa debris were seen adhering to swathers, hay conditioners, balers and bale wagons harvesting infested fields in 1982. Although no firm conclusions could be drawn concerning the extent to which machinery spread of VW had occurred in southern Alberta, research in Washington State (6) had shown that *V. albo-atrum* infected plant debris spread onto an alfalfa field immediately after cutting could initiate VW, as could cutting a healthy stand with an infested mower.

Table 3. Machinery use patterns on farms with verticillium wilt of alfalfa in southern Alberta, 1982.

Use pattern	No. fields
Used own machinery	40
Used own machinery and occasionally cut fields for relatives or neighbors	9
Used own machinery and occasionally hired a custom operator to cut hay	12
Hired a custom operator to cut hay	8
Unknown	3
	72

Although two cuts per season was the most common practice amongst alfalfa producers in southern Alberta, some took a third cut if sufficient regrowth occurred after the second harvest. VW was found in fields subjected to both two and three cuts/season (Table 4); however, a greater proportion of the two-cut fields were infested. Although most producers claimed that the alfalfa was used on their own farms, a significant number sold all or part of their crop to cattle feeders, dairies or dehydration plants. Hence, the movement of infested hay may have served to spread VW to locations where the disease was not previously present. Over 80% of the alfalfa fields with VW in 1982 were hay crops, with the remainder being used for pasture or dehydration.

Thirty-one (43%) of the VW-infested fields identified in 1982 were plowed, in whole or in part, by the fall in an effort to reduce the risk of disease spread (Table 5). An additional 18 fields (25%) were scheduled to be taken out of alfalfa production by fall, 1983. The remainder, most of which had a light incidence of the disease, were designated to be rotated out of alfalfa within the following 3-5 years.

Other alfalfa diseases encountered during the 1982 survey were alfalfa mosaic [Alfalfa Mosaic Virus], anthracnose [*Colletotrichum destructivum* O'Gara], blackstem and leaf spot [*Phoma medicaginis* Malbr. & Roum.], crown and root rot [*Fusarium* spp., *Pythium* spp. and bacteria], downy mildew [*Peronospora trifoliorum* de Bary], yellow leaf blotch [*Leptotrichila medicaginis* (Fckl.) Schuepp.] and miscellaneous abiotic disorders. Crown and root rot, incited mainly by species of *Pythium* and *Fusarium* (17), was the most destructive of these diseases and it occurred in nearly every field over two years of age. In many cases, it was even more destructive than VW and reduced stand productivity to the point where it was no longer economical to maintain some fields. Crown rot was prevalent in both irrigated and dryland fields and seemed to be worse in stands that were under drought stress, too frequently cut, or suffering from winter injury.

Verticillium wilt in 1983. VW was the most serious in irrigated hay fields in the Lethbridge-Taber area (Table 1; Fig. 2). It was confirmed for the first time in three alfalfa seed fields in CD 2, one near Vauxhall and two near Brooks, but disease incidence was very low (<1%). A new northern limit for VW was established with the confirmation of one lightly infested field near Strathmore (Fig. 2).

Verticillium wilt in 1984. VW remained confined to irrigated alfalfa fields used for hay and dehydrated products, and it continued to be the most widespread in the Lethbridge-Taber area (Table 1; Fig. 2). Disease incidence ranged from a trace to high (1-30%).

Verticillium wilt in 1985. Fifty-three fields were surveyed and VW was found in 18 (34%) (Table 1; Fig. 2). Sixteen of these fields were irrigated and two were dryland. The dryland fields were located in CD 6, southwest of Calgary. These locations represented the most westerly distribution ever noted for VW in southern Alberta. VW occurred in dryland fields at trace levels (<1%), while in irrigated fields the incidence ranged from 1-25%.

Table 4. Cuts per season, disposition and end use of alfalfa crops on farms with verticillium wilt in southern Alberta, 1982.

Cuts per season		Disposition of crop		End use of crop	
Type	No. fields	Type	No. fields	Type	No. fields
Two cuts	43	Own use	42	Hay	57
	16	Sold	13	Pasture	3
Three cuts	8	Own use and sold	13	Pasture & hay	4
				Dehydration	4
Undetermined	21	Undetermined	4	Dehy & hay	4
	72		72		72

Verticillium wilt in 1986. Ninety-three fields were surveyed and VW was found in 17 (18.3%) (Table 1; Fig. 2). All of the infested fields were irrigated. Three were located 33 km northeast of Strathmore, which represented the most northerly occurrence of the disease to that date. Between 1980-86, over 600 alfalfa fields in central and northern Alberta also were surveyed for VW by staff of various agencies, and none was found (I.R. Evans, Alberta Agriculture, personal communication). An isolated outbreak of VW occurred in research plots at the University of Alberta, Edmonton, in 1987, although it was likely that the disease had become established one or two years earlier (J.P. Tewari, University of Alberta, personal communication). The disease had been eradicated from this location by 1988.

Table 5. Status of alfalfa fields with verticillium wilt in southern Alberta, 1982.

Status	No. fields
Plowed by fall '82	28
Plowed worst areas of field by fall '82	3
Anticipate plowing by spring '83	6
Anticipate plowing by fall '83	12
Keeping crop	16
Unknown	7
	72

Conclusions

During the period 1980-86, VW became a major new disease of alfalfa in the irrigated region of southern Alberta, and it was often destructive enough to cause fields to be taken out of production. It is certain that the disease was established in Alberta prior to 1980 because Sheppard and Needham (19) confirmed the alfalfa strain of *V. albo-atrum* in 2 of 90 lots of alfalfa seed from the crop of 1978. The infested lots orginated from fields in the Brooks area. Efforts to confirm the presence of VW in the source fields in 1979 were unsuccessful (13) and it was concluded that the infected plants had died or were so few as to escape visual detection.

Although it appears that VW was introduced into southern Alberta on infested seed, it seems likely that the disease was spread locally mainly by machinery, infested plant material, insects and livestock (8, 12, 15). Considering the many means by which dissemination can occur, it is probable that VW will continue to spread northward in Alberta. The destruction caused by the disease in alfalfa plots at the University of Alberta in 1987 proved that the disease has the potential to develop in central Alberta. The preference of the pathogen for moist, cool climatic conditions may mean that many of the alfalfa-producing areas of central and northern Alberta are at risk from VW. The fact that it has not yet been detected in commercial fields in these areas may be due to less intensive production practices relative to southern Alberta and to subtle differences in environmental conditions that influence the survival, spread and/or pathogenicity of *V. albo-atrum*.

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Literature cited

1. Atkinson, T.G. 1981. Verticillium wilt of alfalfa: challenge and opportunity. Can. J. Plant Pathol. 3:266-272.
2. Arny, D.C. and C.R. Grau. 1985. Importance of verticillium wilt of alfalfa in North America. Can. J. Plant Pathol. 7:187-190.
3. Aube, C. and W.E. Sackston. 1964. Verticillium wilt of forage legumes in Canada. Can. J. Plant Sci. 44:427-432.
4. Christen, A.A. 1982. A selective medium for isolating *Verticillium albo-atrum* from soil. Phytopathology 72:47-49.
5. Christen, A.A. and R.N. Peaden. 1981. Verticillium wilt in alfalfa. Plant Dis. 65:319-321.

6. Christen, A.A. and R.N. Peaden. 1982. Relative importance of sources of verticillium wilt infestation in alfalfa. Phytopathology 72:960 (Abstr.).
7. Graham, J.H., R.N. Peaden and D.W. Evans. 1977. Verticillium wilt of alfalfa found in the United States. Plant Dis. Rep. 61:337-340.
8. Harper, A.M. and H.C. Huang. 1984. Contamination of insects by the plant pathogen *Verticillium albo-atrum* in an alfalfa field. Environ. Entomol. 81:1799-1802.
9. Hawksworth, D.L. and P.W. Talboys. 1970. *Verticillium albo-atrum*. Descriptions of Pathogenic Fungi and Bacteria, No. 255. Commonw. Mycol. Inst., Kew, Surrey, England. 2pp.
10. Heale, J.B. 1985. Verticillium wilt of alfalfa, background and current research. Can. J. Plant Pathol. 7:191-198.
11. Horricks, J.S. 1980. Plant disease surveys: forage crops. Pg. 68 *in* 1979 Annual Report, Plant Industry Division, Alberta Agriculture, Edmonton.
12. Howard, R.J. 1985. Local and long-distance spread of *Verticillium* species causing wilt of alfalfa. Can. J. Plant Pathol. 7:199-202.
13. Howard, R.J. and E.R. Moskaluk. 1982. Verticillium wilt of alfalfa in southern Alberta. Can. J. Plant Pathol. 4:306 (Abstr).
14. Howard, R.J. and E.R. Moskaluk. 1989. Survey for verticillium wilt of alfalfa. Can. Plant Dis. Surv. 69:48.
15. Huang, H.C., R. Hironaka and R.J. Howard. 1986. Survival of *Verticillium albo-atrum* in alfalfa tissue buried in manure or fed to sheep. Plant Dis. 70:218-221.
16. Huang, H.C., L.M. Phillippe, R.J. Howard and E.R. Moskaluk. 1988. Survey of verticillium wilt of alfalfa in southern Alberta. Can. Plant Dis. Surv. 68:63-64.
17. Hwang, S.F., R.J. Howard and E.R. Moskaluk. 1989. Crown and root rot of alfalfa in southern Alberta. Can. Plant Dis. Surv. 69:9-11.
18. Sheppard, J.W. 1979. Verticillium wilt, a potentially dangerous disease of alfalfa in Canada. Can. Plant Dis. Surv. 59:60.
19. Sheppard, J.W. and S.N. Needham. 1980. Verticillium wilt of alfalfa in Canada: Occurrence of seed-borne inoculum. Can. J. Plant Pathol. 2:159-162.

Effects of soil pH and nutrients on growth of apple seedlings grown in apple replant disease soils of British Columbia

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Relationships between McIntosh apple seedling growth and pH along with soil nutrients in 568 apple replant disease (ARD) soils were examined by regression analysis. Sixty percent of the ARD soils in the Okanagan-Similkameen valleys had pH values between 6-7.5. All three major nutrient elements (N, P and K) had positive relationships with plant height when the soil pH was ≥ 8. When the soil pH was lower than 5.4, only P had positive relationships with plant height. When the soils were treated with monoammonium phosphate or ammonium nitrate, pH had significant negative relationships with the plant height.

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On a étudié par analyse de régression les rapports qui existent entre la croissance de jeunes pommiers McIntosh, le pH et les substances nutritives de 568 sols atteints de la maladie de la replantation. Soixante pourcent de ces sols dans les vallées de l'Okanagan-Similkameen affichent des PH variant de 6 à 7,5. Les trois éléments nutritifs principaux (N, P et K) montrent une corrélation positive avec la hauteur des plants lorsque le pH du sol est ≥ 8. Mais lorsque le pH du sol est inférieur à 5,4, seul le P affiche une corrélation positive avec la hauteur des plants. Lorsque les sols sont traités au phosphate d'ammonium primaire ou au nitrate d'ammonium, le pH montre une corrélation négative significative avec la hauteur des plants.

Introduction

Apple plants of all ages can tolerate extreme soil pH levels which may have an adverse effect on ARD. In pot experiments Hoestra (1968) found good growth of apple seedlings at pH 3.8. Donoho *et al.* (1967) showed that apple trees grew well at pH 3.6 to 4.5, if all other conditions were good. In pot and field experiments, it has been shown that acidification of the soil could alleviate or solve the problem of apple replant disease (Hein, 1972; Hoestra, 1968 and 1973; Hoestra and Kleijburg, 1967; Jonkers and Hoestra 1978). Soils with a low pH are far less conducive to specific apple replant disease than near-neutral soils (Savory 1967). Acidification of ARD soils with neutral pH levels may have a growth stimulating effect on seedlings which is equal to the effect of chloropicrin treatment (Hoestra 1968). In England, replant disease was not observed in soils with pH levels in between 4 and 4.5 (Upstone 1977), although it is well known that apple trees do not grow well at low soil pH levels. In the Okanagan valley, internal bark necrosis may became serious in plants grown in soils at pH under 5.6 and especially when the leaf manganese concentration is above 120 ppm (Fisher *et al.* 1977). In Italy, low pH levels may cause some nutrients to be unavailable to apple trees (Fregoni and Visai, 1970) and deficiencies of Mn and Cu have been observed in trees growing in soils at pH under 5.0 (Mulder and Butijn 1963).

This paper describes relationships between soil pH, nutrients and the growth of apple seedlings based on 568 apple replant disease soil samples and the effect of nitrogen, phosphorus and other minor nutrients on apple seedling growth.

Materials and methods

The occurrence of apple replant disease in the Okanagan-Similkameen valleys of British Columbia was determined by growing apple seedlings in 568 soil samples collected from old apple orchards throughout the valley. Each soil sample was collected from the root zones 5 to 30 cm below the surface under 3-4 standing fruit trees with a total weight of about 25 kg, and was mixed thoroughly and sieved through a 6 mm sieve to remove stones and the larger root fragments. The samples were stored in polyethylene bags at 18-20°C.

For chemical analyses, half litre soil samples were sent to the Soil Testing Laboratory, British Columbia Ministry of Agriculture and Fisheries, 1873 Spall Road, Kelowna, British Columbia, V1Y 4R2.

McIntosh apple seedlings were used for the pathogenicity tests. The seeds were placed on moist paper towels, sealed in plastic bags and stratified at 0-2°C for 10 weeks. The seeds were then planted in a peat moss and perlite mixture (1:1). Germination occurred within one week at 20°C and seven days later, the seedlings were selected for uniformity. For each treatment 0.5 L of a soil sample was placed in six replicate 10 cm (round) pots and one seedling was planted in each pot. The seedlings were grown in a greenhouse (20 ± 2°C) with fluorescent light (140 lux) to supplement natural daylight for a 14 h photoperiod. For the fertilizer treatments, monoammonium phosphate

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(11-55-0, 1 g/L) and ammonium nitrate (34-0-0, 0.33 g/L), were mixed with the soil separately one day prior to transplanting of apple seedlings. Controls were orchard soil without any treatments. Plant height was recorded 14 weeks after transplanting. The data for plant growth at different pH levels or levels of nutrients and the regression coefficients are presented in this report.

Results and discussion

I. Variation in pH, N and P levels.

About 60% of the soil samples had pH values between 6 and 7.5 (Table 1) which is considered the optimal range for growing apple trees (Jonkers and Hoestra 1978). Hoyt and Neilsen (1985) observed significant positive relationships between tree size and pH levels in three of six orchards studied. Values of pH higher than 8 and lower than 5.4 were observed in 3.6% and 9.1% of the soil samples, respectively, which is considered to be inadequate for good growth of apple trees and require lime or sulphur treatment before planting.

Total available nitrogen levels in the soil samples were divided into three groups: low (0-10 ppm), medium (11-30 ppm) which is the recommended level for apple production, and high (≥ 31 ppm). About one third of the samples had levels of available N within each of the three groups (Table 1).

Table 1. Percentage of soil samples with various levels of pH, nitrogen and phosphorus

pH levels		%
> 8		3.6
7.6-7.9		12.4
6.0-7.5		60.4
5.5-5.9		14.5
< 5.4		9.1
N (ppm)		
0-10	(low)	27.9
11-30	(medium)	39.4
31	(high)	32.7
P (ppm)		
0-30	(low)	21.4
31-60	(medium)	26.1
61-100	(high)	19.6
101	(very high)	32.9

Table 2. Regression coefficients between N, P and K in soil and the growth of apple seedlings at 5 pH ranges

	pH levels				
Nutrients	> 8	7.6-7.9	6-7.5	5.5-5.9	< 5.4
N	0.29*	1.00*	0.08*	0.16*	0.05
P	0.42*	0.02	0.09*	0.004	0.13*
K	0.68*	0.02	0.03	0.005	0.001

* Significant at P = 0.05.

Phosphorus levels in soils (Table 1) were divided into four categories, low (0-30 ppm), medium (31-60 ppm), high (61-100 ppm) and very high (≥ 101 ppm). Twenty-one percent of soils had low levels of phosphorus and 33% of soils had very high levels.

II. The effect of pH, N, P and K on plant growth.

A. Relationship between pH and N, P, K. Nitrogen level in soils and plant height had significant positive relationships at all pH levels except 5.4 (Table 2). Significant relationships were also observed between P levels and plant height in 3 ranges of pH levels (≥ 8, 6-7.5, and < 5.4). This indicates that higher P levels in the soil within these three pH groups have a positive effect on the growth of apple seedlings. This is in contrast to the findings of Wilcox *et al.* (1947) who reported that additional P was not essential for orchard soils of the Okanagan-Similkameen valleys. Soil pH influences the solubility of the essential nutrients that are capable of interacting with soluble P. In general, if the soil pH is lower than 5.4, Fe and Al will fix P in the soil and it will not be available for plants. On the other hand, with higher soil pH, Ca and Mg will interact with P, which would affect the availability of these nutrients (Bradfield *et al.* 1935; Ellington 1978; Munson 1978). Apple seedling growth was increased with increased levels of K in the soil in the pH ranges of ≥ 8. It is interesting to note that all three major nutrient elements had positive relationships with plant growth in the group of pH ≥ 8.

B. Relationship between P and pH, N. No significant effect was observed in plant growth between pH and 4 levels of phosphorus in the soil (Table 3). However, plant growth showed significant increases with higher N in the soil within the groups of medium, high and very high levels of P.

III. The effect of pH, K, Ca and Mg on plant growth after application of monoammonium phosphate in the soil.

In the last five years, the orchardists of British Columbia have been using monoammonium phosphate to obtain good growth of apple trees during their planting on

Table 3. Regression coefficients between pH, nitrogen levels and the growth of apple seedlings at 4 phosphorus levels

Soil factors	Phosphorus levels (ppm) Low <30	Medium 31-60	High 61-100	Very high >101
pH	-0.03	-0.001	0.003	-0.02
Nitrogen level	0.02	0.07*	0.07*	0.13*

* Significant at P = 0.05.

replant disease soils. The results of the present experiment indicated that plant growth was negatively affected with soil pH when the soils were treated with monoammonium phosphate (11-55-0) (Table 4). This shows significantly higher growth at low soil pH when the supply of N and P is adequate. This confirms earlier observations made by Jonkers and Hoestra (1978), Tiedjens and Black (1932) and Jonkers *et al.* (1980). Tiedjens and Black (1932) indicated that, at lower pH, plant growth was better as nitrate nitrogen was absorbed more efficiently by the roots. Plant height was not affected by K in the soils which were supplemented with monoammonium phosphate (N and P). Wilcox *et al.* (1947) reported that the Okanagan-Similkameen valley soils had adequate K and additional K would not enhance plant growth.

Table 4. Regression coefficients between plant height and pH, K, Ca and Mg after monoammonium phosphate soil application

	Soil factors pH	K	Ca	Mg
Plant height	-0.15*	-0.02	-0.06*	-0.01

* Significant at P = 0.05.

When the orchard soils had adequate supplies of N and P, Ca showed negative effects on plant height (Table 4), but was not affected by Mg. This indicates that under adequate N and P levels in the soil, plant growth will increase with low Ca contents.

IV. Relationship between plant height and pH, P after the application of ammonium nitrate in the soil.

It is a general practice for the orchardists in British Columbia to apply ammonium nitrate (34-0-0 NPK) to apple trees to obtain good growth. The results of the present experiment indicated that when ammonium nitrate was applied to the soils, plant height was negatively affected by soil pH levels (Table 5). However, plant height had a positive relationship with P when the level of N in the soil was amended. These results and those in Table 4 indicate that the growth of apple seedlings is better in soils with ample N, a lower pH and high P level.

Table 5. Regression coefficients between plant height and pH, P after ammonium nitrate was applied

	Soil factors pH	P
Plant height	-0.13*	0.09*

* Significant at P = 0.05.

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Literature cited

1. Bradfield, R., G. Scarseth and J.G. Steele. 1935. Factors affecting the retention of phosphate by clays. Trans. Third Int. Cong. Soil Sci. 1:74-75.
2. Donoho, C.W., J.M. Beattie, E.S. Banta, H.Y. Jr. Forsythe. 1967. Possible cause of a disorder known as apple tree decline. HortScience 2(4):149-150.
3. Ellington, P. 1978. Crop yield responses to phosphorus. In: Phosphorus for agriculture – a situation analysis. Potash/ Phosphate Institute, Atlanta, GA, pp. 25-41.
4. Fisher, A.G., G.W. Eaton and S.W. Porritt. 1977. Internal bark necrosis of Delicious apple in relation to soil pH and leaf manganese. Can. J. Plant Sci. 57:297-299.
5. Fregoni, M. and C. Visai. 1970. (Studies on apple dieback in Valtellina. II.) Ann. Fac. Agrar. Univ. Cattol. Sacro Cuore, Milan 10(1/3):251-290.

6. Hein, K. 1972. Beitrage zum Problem der Bodenmudigkeit. Gartenbau-wissenschaft 35:47-71.
7. Hoestra, H. 1968. Replant diseases of apple in the Netherlands. Mede Landbouwhogesch, Wageningen 68: 105 pp.
8. Hoestra, H. 1973. Les méthodes de contrôle de la fatigue du sol en culture fruitière. Le Fruit Belge 364:289-290.
9. Hoestra, H. and P. Kleijburg. 1967. De invloed van de pH van de grond op het optreden van bodemmoeheid by appel. Neth. J. Plant Pathol. 73:65-66.
10. Hoyt, P.B. and G.H. Neilsen. 1985. Effects of soil pH and associated cations on growth of apple trees planted in old orchard soil. Plant Soil 86:395-401.
11. Jonkers, H. and H. Hoestra. 1978. Soil pH in fruit trees in relation to specific replant disorder of apple. I. Introduction and review of literature. Sci. Hortic. 8:113-118.
12. Jonkers, H., H. Hoestra, O. Borsboom and A. Pouwer. 1980. Soil pH in fruit trees in relation to specific apple replant disorder (SARD). II. The first five years at the Wageningen Research Plot. Sci. Hortic. 13:149-154.
13. Mulder, D. and J. Butijn. 1963. Voedingsziekten van fruitgewassen. Netherlands. Ministerie Landbouw en Visserij. Directie Tuinbouwvoorlichting Nr. 11., 74 pp.
14. Munson, R.D. 1978. Efficiency of uptake of P and interaction of P with other nutrients. In: Phosphorus for agriculture – a situation analysis. Potash/Phosphate Institute, Atlanta, GA, pp. 13-24.
15. Savory, B.M. 1967. Specific replant disease of apple and cherry. East Malling Research Station Annual Report, pp. 205-208.
16. Tiedjens, V.A. and M.A. Black. 1932. Factors affecting the use of nitrate and ammonium nitrogen by apple trees. New Jersey Agricultural Experimental Station Bulletin 547.
17. Upstone, M. 1977. New apple rootstock seen as one answer to replant disease. Grower 87(11):635,637.
18. Wilcox, J.C., B. Hoy and R.C. Palmer. 1947. Orchard fertilizer test in the Okanagan valley. Sci. Agric. 27:116-129.

Populations of propagules of *Mucor* spp. during immersion dumping of Anjou pears

P.L. Sholberg and G.R. Owen[1]

Water used for immersion dumping of Anjou pears was sampled for *Mucor piriformis* at a commercial packinghouse. Untreated and filtered water contained an average of 62.6 and 126.0 propagules/ml *Mucor* spp. respectively. This was 4.9 and 9.8 times more than was found in chlorinated (50-100 µg/ml available chlorine) dump-water which contained an average of 12.6 propagules/ml. The importance of dump-water sanitation for the control of rot caused by *Mucor piriformis* is discussed.

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On a échantilloné l'eau utilisée pour la vidange par immersion des poires Anjou pour la présence de *Mucor piriformis* dans un établissement d'emballage commercial. L'eau non traitée et filtrée contenait en moyenne 62,6 et 126,0 propagules/ml d'espèces de *Mucor* respectivement, soit 4,9 et 9,8 fois plus que dans l'eau de vidange chlorée (50 à 100 mg/ml de chlore disponible) qui contenait en moyenne 12,6 propagules/ml. Les auteurs discutent de l'importance de l'hygiène de l'eau de vidange dans la lutte contre la pourriture causée par *Mucor piriformis*.

Introduction

Mucor piriformis Fischer causes decay in pears which may be at the stem-end, at the calyx-end, in the core region or anywhere on the fruit surface (8). It was first recorded as a postharvest pathogen of Anjou pears in the Okanagan Valley in 1971 (3). Since 1971, *M. piriformis* has been identified several times, primarily on Anjou pears, but has also been identified on apples and peaches in cold storage (Sholberg, unpublished). In 1985 the pathogen caused an estimated loss of $70,000 to a British Columbia packinghouse due to decay and repacking costs.

Dobson et al. (2) showed that propagules of *M. piriformis* accumulate in the orchard on infected fallen fruit and become incorporated into the orchard soil. Michailides and Spotts (4) found that *M. piriformis* was absent in samples of leaves, fruit and air collected during harvest. They showed that soil adhering to picking bins was a very important source of inoculum. The fruit are inoculated with *M. piriformis* propagules when they are floated out of the picking bins into water containing soil contaminated with *M. piriformis* (5).

This study was undertaken to determine the importance of immersion water as a source of inoculum for *M. piriformis* in British Columbia and to find out if the inoculum could be reduced by filtration or chlorination under commercial operating conditions.

Materials and methods

Sampling. Dump-tank water at a commercial packinghouse in British Columbia containing sodium sulfate as a floatation salt was sampled daily during emptying of bins (360 kg/bin) of Anjou pears from storage at 0°C. Dump-tank water was sampled in 1985 on November 20 to 28; in 1986 on December 2 to 11 and in 1988 on January 19 to 22. The water was sampled by immersing a 250 ml sample bottle into a flume approximately 3 meters from the dump-tank where pears were immersed to remove them from the bins.

Populations of propagules of *Mucor* spp. and *Penicillium* spp. were monitored by taking 0.1 ml of the sampled dump-tank water and spreading it over a petri plate 50 mm in diameter containing 10 ml of potato dextrose agar (Difco, Detroit, MI) acidified with 15 ml of 85% lactic acid per liter (APDA) and incubating for 2-3 days at 10°C for *Mucor* spp. and at 25°C for *Penicillium* spp. If the dump-tank water contained chlorine the APDA plates were immediately inoculated at the packinghouse because the effect of chlorine increased with time of exposure. At least 3 plates were inoculated for each sample of dump-tank water taken. After incubation at 10°C for 2-3 days, *Mucor* spp. colonies were counted with the aid of a stereo-microscope. The colonies of *Mucor* spp. were distinguished by their stiff whisker-like appearance. *Penicillium* spp. were counted after 3 days and checked 6 days later for typical blue-green sporulation.

Filtration. The dump-tank used for the filtration study held 20,000 L of water which was filtered by using a circulating pump (Model No. RPF 700, Pac. Fab. Inc., Sanford, NC) delivering 250 L/min at 69 kPa through two Jacuzzi sand filter units (Model 24 FM-6, Jacuzzi Canada Ltd., Rexdale, Ont.) containing #16 silica sand and connected in parallel for a total surface area of 0.5574 m^2. A pressure switch automatically turned on a red signal light and shut off the circulating pump when the pressure between the intake and outlet varied by more than 69 kPa.

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The sand filter was backwashed manually with an external source of pressurized domestic water. Backwash water was sampled for *Mucor* spp. propagules on December 9 and 12, 1986 in the same manner as described above. Small amounts of water (20-50 L) were occasionally added to the dump-tank to keep the level adequate for moving fruit.

Chlorination. Dump-tank water was chlorinated by adding 12% commercial grade sodium hypochlorite to the dump-tank to maintain a concentration of 50-100 µg/ml of available chlorine in the water. This was accomplished by injecting the sodium hypochlorite in the dump-tank with an injector pump (Chem-Feed Model No. C 6125P, Blue-White Industries, Westminster, CA) which was operated when the dump-tank circulating pump was running. The pH of the dump-water was monitored daily at the packinghouse with indicator paper for a rough estimate of pH and again at the laboratory with a pH meter (Fisher Accumet pH Meter, Fisher Scientific Co., USA) to determine if buffer needed to be added to the dump-tank. A pH range of 8.0 to about 8.5 has been recommended to give the best balance between stability and effectiveness of chlorine (12). Available chlorine of the dump-tank water was measured several times each day with a colorimetric test kit (Pennwalt Corp., Monrovia, CA 91016).

Results and discussion

Propagule levels of *Mucor* spp. in untreated dump-tank water averaged 62.6 ± 74 propagules/ml (Table 1). However propagule levels ranged from 0, after the first bins of pears were dumped, to 240 when the final bins were dumped. These levels were comparable to levels previously reported by Spotts and Cervantes (11) who never found more than 427/ml. The levels of *Mucor* spp. propagules in the dump-tank are extremely variable because they depend upon the amount of soil adhering to the picking bins and concentration of *Mucor* spp. propagules in the soil (5). In a study of 51 Anjou pear orchard soils in the vicinity of the packinghouse the soil ranged from 0 to 3.45 X 10^5 propagules per gram of dry soil (6). Furthermore, not all *Mucor* spp. found in the orchard soil were pathogenic to Anjou pear. We estimate that 73.5% of the propagules in the dump-tank would be pathogenic because this value was found in the orchard soils (6).

Table 1. Number of propagules of *Mucor* spp./ml in Anjou pear dump-tank water.

Water Treatment	Date Sampled	Total Bins Emptied	Av. No. Propagules/ml
None	Nov. 20-29, 1985	792	62.6 ± 74
Filtered	Dec. 3-12, 1986	999	126.0 ± 53
Chlorinated	Jan. 19-22, 1988	497	12.8 ± 11

The filter removed propagules of *Mucor* spp. from the dump-water although the filtered water contained a higher average number of propagules than unfiltered water from the previous year (Table 1). On December 9, 1986 the backwash water contained 3633 propagules/ml and the dump-tank contained 106 propagules/ml and on December 12 the backwash water contained 2866 propagules/ml and the dump-tank contained 70. Since the backwash water contained 34.3 to 40.9 times more propagules than the filtered water in the dump-tank we concluded it was capable of removing *Mucor* spp. propagules.

Unfortunately the filter left too many *Mucor* spp. propagules in the dump-tank. On December 5, 1986 after the filter had been operating intermittently for 3 days the number of *Mucor* spp. propagules/ml reached 210 which is sufficient to decay 10% of wounded Anjou pears (9). This inoculum would also likely be enough to inoculate fruit at the stem and calyx end causing stem and calyx end rot. The filter would have to be used in conjunction with another means of removing postharvest pathogens from the dump-water in order to be effective. It may be possible to use filtration in addition to chlorination to improve the performance of the treatment. Filtered Red Delicious apple-dump-water that was chlorinated with 50-100 µg/ml chlorine contained 7.0 propagules/ml of *Penicillium* spp. compared to 22.8 for nonfiltered chlorinated water (7).

Chlorination of Anjou pear dump-water is very effective in preventing decay by *M. piriformis* (1). In our trial, chlorine appeared beneficial because it allowed an average of only 12.8 propagules/ml to survive. Prior to adding chlorine to the water it contained 43.0 ± 20.0 propagules/ml and when the average number of propagules was compared to values found in previous years the values were much lower in chlorinated water (Table 1). Although several bins of fruit were immersed in the dump-tank the number of propagules changed very little from day to day ranging from 0 to 27 propagules/ml (Table 2). This small number would not likely cause significant infection under commercial conditions as Spotts (9) showed that 25 spores/ml corresponds to 1.25% infection on wounded pears. Under commercial conditions it was estimated that approximately 5% of the pears would be wounded and only 73.5% of the propagules would be pathogenic, making it unlikely that significant decay would occur unless a higher number of propagules were present in the water. Furthermore, as shown in Table 2, decay by *Penicillium* was kept under control because the number of propagules of *Penicillium* spp. never rose above 166 ± 70 propagules/ml.

It is apparent from this study and those of others (1,10) that addition of 50-100 µg/ml chlorine to the dump-water is effective in destroying *Mucor* spp. propagules. It should be noted, however, that this is somewhat dependent on the floatation salt used. Spotts and Cervantes (12) found that when sodium sulfate at pH 7.8 was compared with sodium silicate at pH 11.2 in chlorinated water, the sodium sulfate water inhibited germination to a greater extent.

Table 2. Number of propagules/ml of *Mucor* spp. and *Penicillium* spp. in Anjou pear dump-water chlorinated with 50-100 µg/ml chlorine for 4 days

Day	Total Bins	Free Chlorine µg/ml	pH	Propagules/ml* *Mucor* spp.	*Penicillium* spp.
1	23	75	7.9	0±0	0±0
2	181	90	7.8	12±16	45±40
3	338	100	7.6	27±47	20±11
4	497	100	7.6	12±14	166±70

* Prior to adding sodium hypochlorite to the immersion water it contained 43.0 ± 20.0 *Mucor* spp. propagules/ml because the water was previously used for floating apples out of bins.

This study showed that propagules of *M. piriformis* occurred in sufficient numbers to cause pear decay at a commercial packinghouse in British Columbia. In order to reduce *Mucor* rot and avoid the costly inconvenience of repacking, packinghouse managers should use a sanitizing agent such as 50-100 µg/ml chlorine in the dump-tank. In addition, the dump tank should be emptied and thoroughly cleaned whenever the water becomes dirty. Spotts (9) found that using a spray rinse with clean water after the pears had been contaminated with spores reduced decay caused by *Botrytis cinerea, Penicillium expansum* and *M. piriformis*. This could be accomplished in the packinghouse by adding a spray nozzle above the pears as they come out of the dump-tank. Orchardists should be encouraged to place harvest bins on wood chips or some surface which prevents direct contact with soil, and fruit should never be removed from the ground and placed in the harvest bin. Fruit on the orchard floor should be removed and kept separate from fruit for packing.

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Literature cited

1. Bertrand, P.F. and J.L. Saulie-Carter. 1979. Postharvest decay control of apples and pears after immersion dumping. Oregon State University Experimental Station Report 545. 9 pp.
2. Dobson, R.L., T.J. Michailides, L.A. Cervantes and R.A. Spotts. 1989. Population dynamics of *Mucor piriformis* in pear orchard soils as related to decaying pear fruit. Phytopathology 79:657-660.
3. Lopatecki, L.E. and W. Peters. 1972. A rot of pears in cold storage caused by *Mucor piriformis*. Can. J. Plant Sci. 52:875-879.
4. Michailides, T.J. and R.A. Spotts. 1986. Factors affecting dispersal of *Mucor piriformis* in pear orchards and into the packinghouse. Plant Dis. 70:1060-1063.
5. Michailides, T.J. and R.A. Spotts. 1990. Postharvest diseases of pome and stone fruits caused by *Mucor piriformis* in the Pacific Northwest and California. Plant Dis. 74:537-543.
6. Sholberg, P.L. and G.R. Owen. 1987. Incidence of pathogenic *Mucor* spp. in Anjou pear orchards in the Okanagan Valley of British Columbia. Can. Plant Dis. Surv. 67:9-10.
7. Sholberg, P.L. and G.R. Owen. 1990. Populations of propagules of *Penicillium* spp. during immersion dumping of apples. Can. Plant Dis. Surv. 70:11-14.
8. Snowdon, A.L. 1989. A colour atlas of post-harvest diseases and disorders of fruits and vegetables. CRC Press. Boca Raton. 220 pp.
9. Spotts, R.A. 1986. Relationships between inoculum concentrations of three decay fungi and pear fruit decay. Plant Dis. 70:386-389.
10. Spotts, R.A. and B.B. Peters. 1980. Chlorine and chlorine dioxide for control of d'Anjou pear decay. Plant Dis. 64:1095-1097.
11. Spotts, R.A. and L.A. Cervantes. 1986. Populations, pathogenicity, and benomyl resistance of *Botrytis* spp., *Penicillium* spp., and *Mucor piriformis* in packinghouses. Plant Dis. 70:106-108.
12. Spotts, R.A. and L.A. Cervantes. 1989. Evaluation of disinfectant-floatation salt-surfactant combinations on decay fungi of pear in a model dump tank. Phytopathology 79:121-126.

Role of the insect *Nysius niger*, and flixweed, *Descurainia sophia*, in infection of Saskatchewan mustard crops with a yeast, *Nematospora sinecauda*

L. Burgess and D.L. McKenzie[1]

The coincidence of the two outbreaks of the yeast *Nematospora sinecauda* in the seed of mustard crops since 1981 with the two peaks of abundance of *Nysius niger* [formerly known as *N. ericae*] suggests that this insect is of major importance in transmitting the pathogen to the crop. The yeast was shown not to overwinter in *N. niger*, as only the egg stage of this insect survived the winter in southern Saskatchewan. No evidence of adult *N. niger* migrating into southern Saskatchewan from warmer southern latitudes was obtained, indicating that the yeast is not reintroduced in the spring by immigrant insects. Flixweed [*Descurainia sophia*], a common cruciferous weed on the prairies and the main early season host of *N. niger*, was also found to be a host for *N. sinecauda*. Laboratory experiments demonstrated that adults of *N. niger* could acquire *N. sinecauda* inoculum by feeding on naturally infected ripe flixweed seeds collected from the field. Field observations suggested that nymphs also could acquire the inoculum by this same route. *N. sinecauda* was found to survive the prairie winter in ripe infected seeds retained within the pods of mature flixweed plants. Such seeds would provide a source of inoculum for the vector insect in the spring. In conclusion, it appears that both *N. niger* and flixweed play a part in the infection of western Canadian mustard crops with *N. sinecauda*.

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La coincidence des deux épisodes d'infection des graines de moutarde par la levure *Nematospora sinecauda* depuis 1981 avec les deux pics d'abondance de *Nysius niger* [anciennement connu sous le nom de *N. ericae*], donne à penser que cet insecte est d'une grande importance dans la transmission de l'agent pathogène à la culture. Il a été prouvé que la levure n'hivernait pas dans *N. niger*, car seul le stade oeuf de cet insecte survit à l'hiver dans le sud de la Saskatchewan. On n'a aucune preuve voulant que des adultes de *N. niger* migrent dans le sud de la Saskatchewan à partir de latitudes plus chaudes situées plus au sud, ce qui renforce l'hypothèse voulant que la levure ne soit pas réintroduite au printemps par des insectes immigrants. Le sisymbre sophia [*Descurainia sophia*], mauvaise herbe crucifère commune dans les Prairies, principal hôte de *N. niger* en début de saison, s'avère également être un hôte de *N. sinecauda*. Des expériences en laboratoire ont révélé que des adultes de *N. niger* pouvaient acquérir de l'inoculum de *N. sinecauda* en se nourrissant de graines mûres de sisymbre naturellement infectées et récoltées dans le champ. Des observations en plein champ donnent à penser que les nymphes pourraient également acquérir l'inoculum par la même voie. On a constaté que *N. sinecauda* survivait à l'hiver des Prairies dans des graines mûres infectées contenues dans les gousses de plants adultes de sisymbre. Ces graines fourniraient une source d'inoculum à l'insecte vecteur au printemps. En conclusion, il semble que *N. niger* et le sisymbre jouent un rôle dans l'infection par *N. sinecauda* des cultures de moutarde dans l'ouest du Canada.

Introduction

In 1979, a yeast identified as *Nematospora coryli* Peglion was found infecting many commercial seedlots of mustard [*Brassica juncea* (L.) Coss.] grown in the Canadian Prairie Provinces, northern Montana and northern North Dakota (J.S. Hemingway, Colman Foods, Norwich, England 1980, unpub. report to the Mustard Association). Its presence resulted in undesirably high plate counts of microorganisms in condiment flours ground from such seed. Holley *et al.* (1984) reported that the yeast infecting mustard seed is a new and previously undescribed species of *Nematospora*, *N. sinecauda* Holley, Allan-Wojtas & Phipps-Todd, rather than *N. coryli*, which it closely resembles. *N. sinecauda* has also been detected in white mustard [*Sinapis alba* L.] (J.S. Hemingway 1980 unpub. report) and in canola [*Brassica napus* L.] (Burgess and McKenzie, unpublished data).

Burgess *et al.* (1983) identified a hemipterous insect, then commonly known as *Nysius ericae* (Schilling) or the false chinch bug, but now correctly named *Nysius niger* Baker (Ashlock 1977), as a vector of this yeast, but they did not discover how the yeast overwintered. Burgess, Verma and McKenzie (1982, unpublished report to the Mustard Association) determined that the yeast did not appear to overwinter in the soil, nor did sowing infected seed give rise to infected plants. Holley and Jones (1985) added support to the latter finding when they reported that 99.9% of the *Nematospora* originally present in oriental mustard seed was killed within 24 hr during germination of the seed between moist filter papers.

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The present paper reports further investigations of the role of *N. niger* in infecting commercial mustard crops with *N. sinecauda*, and of where the yeast inoculum overwinters. The studies were carried out in southern Saskatchewan, which constitutes the central portion of the western Canadian mustard growing region.

Materials and methods

N. niger nymphs and adults were collected by sweeping flixweed [*Descurainia sophia* (L.) Webb] with a heavy cloth insect net, or by collecting the insects directly from plants or the soil surface with an aspirator. Specimens brought into the laboratory for study or plating were transported in an insulated chest chilled with ice or freezer packs. Insects to be examined for the presence of *N. sinecauda* were frozen and stored at −10 to −12°C; then surface sterilized, crushed, and plated on Difco Standard Methods Agar, as outlined by Burgess *et al.* (1983). Similar procedures were used to detect yeast in flixweed seeds and seedlings.

N. niger populations were estimated by sweeping semi-permanent patches of flixweed. Because *N. niger* often congregated in a small area of a flixweed patch, while being absent or present in low numbers elsewhere in the patch, flixweed patches were not swept with a specific number of strokes. Rather, they were swept extensively to determine if the insects were apparently absent, present in low to moderate numbers, or abundant. In the abundant category, hundreds of insects would be obtained in the sweeps from a patch, usually from one or more dense aggregations of *N. niger*.

To check for the presence of overwintering *N. niger*, 0.25 m^2 samples of leaf litter and turf to a depth of 6 cm were taken in the autumn and winter near sites where *N. niger* was earlier present. This material was brought into the laboratory, warmed to 21-24°C, and hand sorted.

To help determine the developmental stage in which *N. niger* overwinters, in autumn 1984 an emergence cage 13.5 cm high and 0.5 m^2 in area, and additional protective mustard and wheat straw were placed over each of two aggregations of *N. niger* nymphs and adults in a mustard stubble field with unharvested swaths. Each cage enclosed insects on and under a swath, as well as some on the ground in the adjacent stubble. The straw, stubble and soil within the cages were examined carefully for surviving insects the following spring.

Ripened flixweed seeds were collected by sweeping mature plants with a heavy cloth insect net, or by collecting mature pod bearing stems and rubbing the seed out by hand. Seed was then cleaned with a series of fine metal sieves.

Feeding trials on ripened flixweed seed were carried out in the laboratory with field-caught or laboratory-reared (Burgess and Weegar 1986) *N. niger*. These trials were conducted in 13 × 13 × 9 cm clear polystyrene boxes lined on the bottom with paper towelling, with a 5 cm screened port in the lid partly covered with moist dental cotton to provide adequate humidity. In a trial, a number of adults or nymphs were introduced into a polystyrene box containing flixweed seeds on the towelling, and the insects were observed for feeding activity. Similar feeding tests were carried out with ripe *B. napus* and *B. juncea* seeds.

To detect the acquisition of yeast inoculum by *N. niger* feeding on ripened infected flixweed seeds, laboratory reared *N. niger* with no previous contact with *N. sinecauda* were used. The yeast-free status of the laboratory colony supplying the test insects was checked prior to each experiment by plating 10 or 12 insects chosen randomly from the colony. The acquisition trials were conducted in 6 × 2 cm disposable plastic Petri dishes with a filter paper liner on the bottom, and a 9 mm stoppered port on one side for introduction of insects and seeds. Moist dental cotton was again used to provide adequate humidity. In a trial, 50 *N. niger* adults or nymphs were introduced into a Petri dish containing infected flixweed seeds on the filter paper, except that only 24 nymphs were used in one test. The test insects were left in the Petri dish with access to the infected seeds for 24 to 52 hr, then removed and plated to see if they had acquired yeast inoculum by feeding.

To detect the transmission of yeast inoculum to *B. juncea* by *N. niger* adults that had fed on infected flixweed seed, a developing green pod of *B. juncea* was placed on a paper shelf within the Petri dish for the last 24 hr of a 48 hr inoculum acquisition experiment. The shelf kept the infected seed and the *B. juncea* pod physically separated, but allowed the insects ready access to both. Both the insects and the seeds of the test pod were plated for yeast at the end of the experiment. The pod used in this experiment was obtained from a greenhouse-grown yeast-free plot of *B. juncea*, with the pods immediately above and below it on the plant being plated as controls.

To simulate the overwintering of yeast infected flixweed seeds on the ground, which were otherwise difficult to separate from soil and debris, a sample of infected seed was placed on a soft cloth stretched across a small wooden frame. The frame and seed were placed on the ground in a fencerow in early November, and retrieved the following spring for plating. The stretched cloth held the seed just above the soil surface, and a metal screen covering protected the seed from rodent and insect damage.

Results and discussion

Relation of *Nematospora* outbreaks in mustard crops to *N. niger* abundance

Observations in southern Saskatchewan in 1982 and subsequently indicated that flixweed, a common cruciferous prairie weed, is the main early season host plant of *N. niger* before this insect moves into developing mustard crops (Burgess pers. observ.). It was also noted that *N. niger* was almost always more abundant in semi-permanent flixweed patches in wasteland, field margins and old farmyards than in flixweed patches in cultivated or cropped fields. Comparison of the annual June abundance of *N. niger* in semi permanent flixweed patches in southern Saskatchewan with the annual

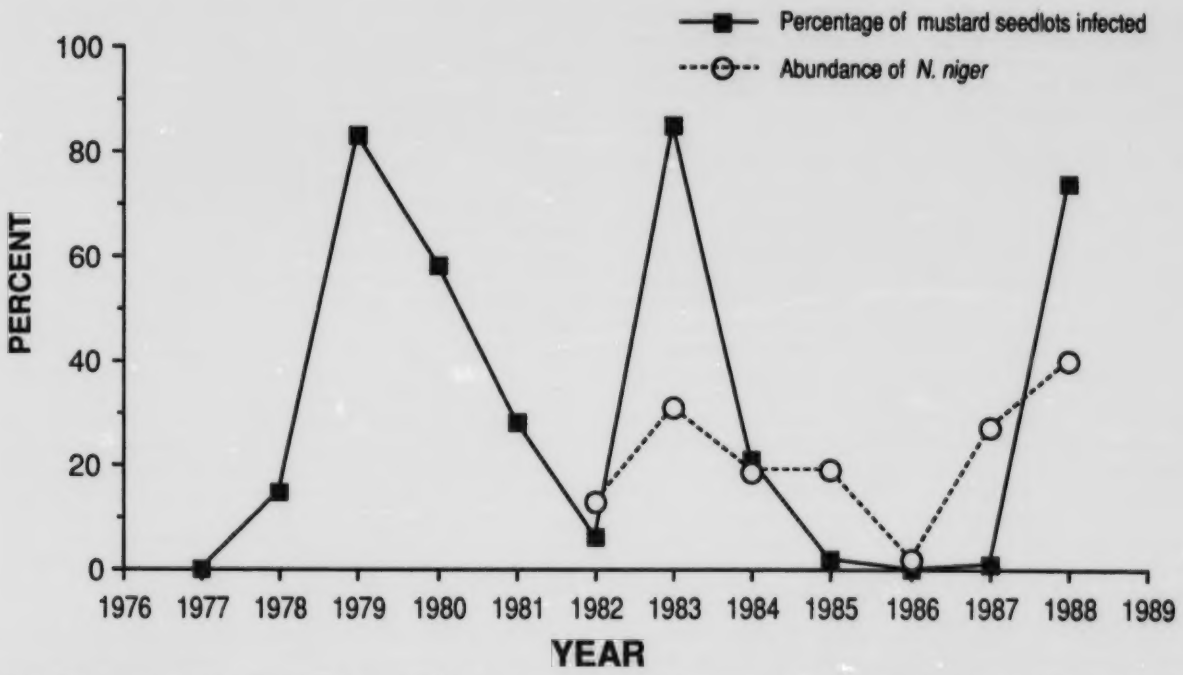

Fig. 1. Percentage of sampled mustard seed lots[1] infected with *Nematospora sinecauda* in the Prairie Provinces – Montana – North Dakota mustard growing area, and June abundance[2] of *N. niger* on flixweed in southern Saskatchewan.
[1] Data include *B. juncea* in all years, and *S. alba* from 1982 onwards, and were obtained by the Mustard Association and Agriculture Canada.
[2] Calculated as the percentage of sites where *N. niger* was abundant in relation to the total number of sites sampled.

percentage of commercial mustard seedlots infected with *Nematospora* in the mustard growing region from 1982 through 1988 (Fig. 1), showed that the two peak years of *Nematospora* infection coincided with the two peak years of *N. niger* abundance. Also, in 1984, when *N. niger* was abundant in flixweed patches in June in southwestern Saskatchewan, but rare in the southeast, the majority of yeast positive mustard seedlots came from southwestern Saskatchewan and southern Alberta. *N. niger* was found in only two of 21 flixweed patches sampled in southeastern Saskatchewan and was abundant in neither, whereas in the southwest it was found in 14 of 18 patches sampled and was abundant in eight. However, the presence of sizable populations of *N. niger* alone did not necessarily produce a *Nematospora* outbreak, as evidenced by the sizable *N. niger* populations recorded in 1985 and 1987 (Fig. 1). The coincidence of the two *Nematospora* outbreaks with peaks of *N. niger* abundance supports the idea that this insect is a major vector of *Nematospora* to mustard crops. Additional evidence of the importance of *N. niger* as a vector was seen in 1988, when yeast positive *N. niger* adults were found on flixweed at four southern Saskatchewan locations in June, whereas no locations with yeast positive *N. niger* had been found in the June survey in the previous two years. These finds were the basis of an accurate alert issued to the mustard industry that an increased incidence of *Nematospora* infected crops could be expected.

While our observations and those reported by Burgess *et al.* (1983) point to the major importance of *N. niger* as a vector of *Nematospora*, some involvement of other insects is not ruled out. *Nematospora* positive western damsel bugs [*Nabis alternatus* Parshley] and *Lygus* bugs were found in southern Saskatchewan in 1981 (Burgess *et al.* 1983) and in 1982, some overwintered *Lygus* adults gave a weakly positive test for yeast [2 colonies/26 insects]. In 1988, four specimens of a stink bug, *Chlorochroa uhleri* (Stal.) that were positive for the yeast were collected from flixweed plants. Stink bugs [Pentatomidae] are well known as vectors of the Nematosporaceae in tropical and subtropical regions (Batra 1973).

Where does *N. sinecauda* inoculum overwinter?

It was first postulated that the yeast might survive the winter in overwintering *N. niger* adults, as it was determined that the yeast remained viable in frozen adults (–10 to –12°C) for more than 12 months, and as *N. niger* has been reported to overwinter as an adult in Alberta (Strickland 1933) and probably also in Saskatchewan (Taylor 1964). Also, Ershad and Barkhordary (1976) found that *N. coryli* overwintered in its insect vectors in Iran. However, our investigations in southern Saskatchewan between 1981 and 1988 yielded no evidence that *N. niger* overwinters here as a nymph or adult. None of 27 samples of leaf litter and turf collected from October to December

1981, near sites where *N. niger* was present earlier in the season, yielded any live nymphs or adults. Each year from 1982 to 1985, a careful early spring examination was made of soil and plant debris at sites where *N. niger* nymphs and adults had been abundant the previous autumn in mustard stubble and beneath unharvested mustard swaths. No evidence of even a single nymph or adult surviving the winter was found, even though densities the previous autumn had sometimes been estimated in thousands per 30 cm square. Placing an emergence cage and additional protective mustard and wheat straw over each of two such aggregations of *N. niger* nymphs and adults in autumn 1984, also produced a negative result. Soil and trash brought into the laboratory from within and around these cages the following spring contained no living adults, and no nymphs until eggs present in these materials hatched a few days later. In annual field observations from 1982 to 1987, including many in flixweed patches, the first *N. niger* nymphs were found between 14 May and 6 June, with the first adults appearing 9-21 days later. Thus it appears that *N. niger* overwinters in the egg stage in southern Saskatchewan, and probably throughout the mustard growing area, as winter conditions in this area tend to be rather uniformly severe. As we could find no published records of yeasts being carried from one generation to the next on or in insect eggs, and Ershad and Barkhordary (1974) found that *N. coryli* was absent from eggs laid by infected adults of the genera *Acrosternum* and *Brachynera*, it seemed unlikely that the yeast overwintered on or in *N. niger* eggs, and other overwintering possibilities for *N. sinecauda* were considered.

The possible reintroduction of the yeast each spring by infected *N. niger* adults migrating into the mustard growing area on winds from warmer, more southerly latitudes was considered. However, the probability that this occurred seemed low. The complete absence of any adult *N. niger* in the study area prior to the appearance of locally developed adults was not suggestive of spring immigration. Also, in the southern states of the U.S.A. that might be expected to be a possible source of yeast positive *N. niger*, if indeed *N. sinecauda* occurs in that area, it has been reported that *N. niger* is replaced by *N. raphanus* Howard (Barber 1947), a species that we did not collect in Saskatchewan at any time during the nine years of the study.

A third possibility was that flixweed, because it is the main early season host of *N. niger*, might serve as an overwintering host for *N. sinecauda* and be the spring source of inoculum for that insect. Evidence that this occurs was obtained when yeast positive *N. niger* nymphs [24 specimens divided into four groups of six; with 4, 56, 60 and 200 yeast colonies per group] were collected on 19 June 1985 from an isolated flixweed patch near Davidson, Saskatchewan. Adults were not yet present at this site, and as nymphs do not fly, it seemed probable that they had acquired the yeast from a source of overwintered inoculum in or near the flixweed patch in which they were found. From late July to early September in the same season, yeast positive adult *N. niger* and additional yeast positive nymphs were found in flixweed patches at various locations, and as well, mature, ripened flixweed seeds collected from two locations proved positive for *Nematospora* [1×10^3 and 2.2×10^4 colonies/g].

With the latter discovery, it was postulated that ripened dormant flixweed seed might be an overwintering vehicle for the yeast. For infected flixweed seed to constitute a spring source of inoculum for *N. niger*, one requirement was that nymphs and adults must feed on the ripened seeds. In July and August 1985, *N. niger* nymphs and adults were observed living on the ground under patches of flixweed in which all plants had senesced and were dry and brittle. This suggested that nymphs and adults, although commonly known as sap suckers in nature, might be feeding on ripened flixweed seeds that had fallen from the pods. This supposition was supported by laboratory feeding tests, in which field collected fourth and fifth instar nymphs and adults fed readily on hard ripened flixweed seeds as well as on ripened canola and domestic mustard seeds. To feed, a nymph or adult grasped a seed between its front tarsi, held it firmly against a paper substrate on the bottom of the test chamber, and drilled deeply into the seed with its mouthparts. As the mouthparts penetrated further into the seed the labial sheath acquired a sharper bend. The time spent feeding on a single seed ranged from about one to more than 30 min. Examination of mustard seeds that were germinated after being fed upon by adult *N. niger* showed that the feeding stylets had penetrated both folded cotyledons, and left areas of brown damaged tissue where no chlorophyll developed.

For overwintered flixweed seeds to be a spring source of *Nematospora* inoculum for *N. niger*, it was necessary also that *N. niger* be able to acquire this inoculum by feeding on *Nematospora* infected seeds. When laboratory reared nymphs and adults were used in inoculum acquisition tests, it was observed that they fed much less readily on ripened flixweed seeds than did their field collected counterparts. In spite of this, two out of five groups of 10 laboratory reared *N. niger* adults became *Nematospora* positive internally [23, 720 colonies/group] after being exposed for 52 h to infected flixweed seed [3.2×10^3 colonies/g]. However, none of 50 fourth and fifth instar nymphs similarly exposed became *Nematospora* positive. Acquisition of *Nematospora* inoculum from infected seed by adults was confirmed in a second test. Five out of 10 groups of five laboratory reared adults of *N. niger* became yeast positive internally [1, 5, 9, 140, 1408 colonies/group] after being exposed to infected seed [7.0×10^7 colonies/g] for 24 hr. Again, none of 24 nymphs similarly exposed became yeast positive. A third experiment, with 50 laboratory reared adults exposed to infected seeds [9.6×10^3 colonies/g] for 48 hours, again confirmed the results of the earlier experiments. Of the 46 adults surviving the experiment, five groups of eight and the remaining group of six had all become yeast positive internally [13, 240, 816, 896, 1696, 2560 colonies/group]. In this experiment adults were permitted to feed also on a greenhouse grown immature *B. juncea* pod for the last 24 hours of the experiment. Plating the seeds of this pod at the end of the experiment yielded 33 colonies of *Nematospora*, while plating of the seeds of two control

B. juncea pods yielded no yeast colonies. Thus it was apparent that *N. niger* adults could acquire *Nematospora* inoculum by feeding on ripened infected flixweed seeds, and transmit it to developing seeds in a healthy mustard pod. The ability of field collected *Nematospora* positive adults to transmit the yeast to the seeds contained in healthy green mustard pods had already been demonstrated by Burgess *et al.* (1983).

A third requirement for overwintered flixweed seeds to be a spring source of *Nematospora* inoculum for *N. niger* was that the yeast must survive the winter in nature in some dormant flixweed seeds. In 1989, it was established that this occurred in a southwestern Saskatchewan flixweed patch whose seed had tested positive the previous September. Ripe dormant seeds, retained over winter within the pods of mature plants in this patch, and collected 19 April, showed a minimum count of 2.1×10^3 colonies of *Nematospora* per gram when plated. Unfortunately, it was not possible to conduct a feeding test with *N. niger* on this seed; however, the level of *Nematospora* infection was of the same order of magnitude as in the seed employed in two of the previous feeding tests when adult *N. niger* acquired *Nematospora* inoculum.

Pod-retained seeds in the spring, in this and other flixweed patches, were most abundant in plants sheltered from the wind by a surrounding dense growth of flixweed or other weeds; the wind had shattered the majority of seeds from isolated plants and those near the patch periphery.

To simulate infected flixweed seeds overwintering on the ground, approximately 4 g of *Nematospora* infected seed [5.7×10^4 colonies/g] was placed on a soft cloth just above the soil surface, as described earlier, in early November 1988. When the seeds were retrieved on 9 May 1989, and subsequently plated, no *Nematospora* was detected. Non survival of the yeast in this seed was perhaps due to the damper conditions existing near the soil surface than in the pods of standing mature plants. Holley and Timbers (1983) have shown that under some conditions, small increases in the moisture content of stored oriental mustard seed reduced *Nematospora* survival.

The foregoing observations indicate that *Nematospora* could overwinter in nature on the western prairies in ripened seeds retained within the pods of mature flixweed plants, and be acquired by *N. niger* adults feeding on these seeds in the following spring. The collection of *Nematospora* positive nymphs on 19 June 1985 suggests that in nature, nymphs also may acquire the inoculum by feeding on overwintered infected flixweed seeds. The failure of nymphs to pick up *Nematospora* in laboratory tests possibly resulted from the low level of seed feeding observed in laboratory reared nymphs.

The possibility of *Nematospora* overwintering in flixweed seedlings was investigated also, since plants arising from seeds germinating in late summer and autumn overwinter in a green vegetative rosette stage. Such plants, collected in the spring from two flixweed patches in 1986 and five patches in 1987, tested negative for *Nematospora*. Both of the 1986 collections came from patches that had infected seed the previous year, and one of the 1987 collections came from a patch that contained infected *N. niger* the previous year. In April 1989, approximately 350 seedings collected from a flixweed patch that had both infected *N. niger* and infected seeds in 1988, and that also yielded infected overwintered seed, likewise proved negative for *Nematospora*. The lack of evidence for overwintering of *Nematospora* in overwintered vegetative flixweed seedlings is not surprising, as the yeasts of the Nematosporaceae are primarily parasites of seeds and fruits (Batra 1973; Preston and Ray 1943; Plurad and Daugherty 1970).

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Literature cited

1. Ashlock, P.D. 1977. New records and name changes of North American Lygaeidae (Hemiptera: Heteroptera: Lygaeidae). Proc. Entomol. Soc. Wash. 79:575-582.
2. Barber, H.G. 1947. Revision of the genus *Nysius* in the United States and Canada (Hemiptera: Heteroptera: Lygaeidae). J. Wash. Acad. Sci. 37:354-366.
3. Batra, L.R. 1973. Nematosporaceae (Hemiascomycetidae): taxonomy, pathogenicity, distribution, and vector relations. U.S. Dep. Agric., Agric. Res. Serv., Tech. Bull. 1469. 71pp.
4. Burgess, L., J. Dueck and D.L. McKenzie. 1983. Insect vectors of the yeast *Nematospora coryli* in mustard, *Brassica juncea* crops in southern Saskatchewan. Can. Entomol. 115:25-30.
5. Burgess, L. and H.H. Weegar. 1986. A method for rearing *Nysius ericae* (Hemiptera – Lygaeidae), the false chinch bug. Can. Entomol. 118:1059-1061.
6. Ershad, D. and M. Barkhordary. 1974. Host range and vectors of *Nematospora* in Kerman of Iran. Iran. J. Plant Pathol. 10:34-39.
7. Ershad, D. and M. Barkhordary. 1976. Investigations on stigmatomycosis (Massu disease) of pistachio. Iran. J. Plant Pathol. 12:17-23.
8. Holley, R.A., P. Allan-Wojtas and B.E. Phipps-Todd. 1984. *Nematospora sinecauda* sp. nov., a yeast pathogen of mustard seeds. Antonie Leeuwenhoek. 50:305-320.
9. Holley, R.A. and J.D. Jones. 1985. The role of myrosinase in the development of toxicity toward *Nematospora* in mustard seed. Can. J. Bot. 63: 521-526.
10. Holley, R.A. and G.E. Timbers. 1983. *Nematospora* destruction in mustard seed by microwave and moisture treatments. Can. Inst. Food Sci. Technol. 16:68-75.
11. Plurad, S.B. and D.M. Daugherty. 1970. Growth parameters of *Nematospora coryli* Peglion (Ascomyceteae: Saccharomycetaceae) and progress of infection in inoculated soybeans. Trans. Mo. Acad. Sci. 4:125-134.
12. Preston, D.A. and W.W. Ray. 1943. Yeast spot disease of soybean reported from Oklahoma and North Carolina. U.S. Dep. Agric. Plant Dis. Reptr. 27:601-602.
13. Strickland, E.H. 1933. Insect pests of grain in Alberta. University of Alberta, Department of Extension, Bull. 24. 58 pp.
14. Taylor, M.E. 1964. Insects of the season 1964 in Saskatchewan. Can. Insect Pest Rev. 42:174-179.

Powdery mildew of babaco at Agassiz, British Columbia

J.G. Menzies and C. Kempler[1]

Babaco (*Carica pentagonia*) plants grown in experimental greenhouse ranges at Agassiz, B.C. were observed to be infected with a powdery mildew pathogen during the period of December to April, 1989. The pathogen infected only the leaves of babaco causing a premature yellowing of the leaves and eventual premature leaf abscission when large numbers of colonies were present. The sexual state of the pathogen was not observed so the pathogen was identified using asexual morphological characteristics. The characteristics of the pathogen closely match those of *Oidium caricae-papayae* Yen as described by Boesewinkel (1980). Inoculation of cucumber, kohlrabi and radish seedlings with conidia of the babaco pathogen did not result in colony formation.

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Des plants de babaco (*Carica pentagonia*) cultivés en serre expérimentale à Agassiz (Colombie-Britannique) se sont révélés infectés par un agent pathogène responsable du blanc au cours de la période de décembre-avril 1989. L'agent pathogène n'infectait que les feuilles de babaco causant un jaunissement et une abscission prématurés des feuilles lorsque le nombre de colonies était suffisamment grand. On n'a pu observer le stade sexué de l'agent pathogène de sorte qu'on l'a identifié au moyen de ses caractères morphologiques asexués. Ces caractères ressemblent étroitement à ceux de *Oidium caricae-papayae* Yen comme les a décrits Boesewinkel (1980). Par contre, l'inoculation de plantules de concombre, de chou-rave et de radis avec des conidies de l'agent pathogène du babaco n'a pas entraînée la formation de colonies.

Introduction

Babaco (*Carica pentagonia*) has been grown for 2 years in experimental greenhouse ranges at the Agriculture Canada research station at Agassiz, B.C. A close relative of the mountain papaya, it is a sterile hybrid between *C. pubescens* Lenne et Kock X *C. stipulata* Badillo (Dawes and Pringle 1983). Plants grow to a height of 2 to 3 metres and bear 50 or more parthenocarpic marrow-like fruit per plant, which may take 6 to 8 months to mature. The objective of the Agassiz babaco program is to determine if babaco can be grown as an alternative crop in commercial greenhouses in south coastal British Columbia.

Epiphytic colonies of powdery mildew were first observed on the upper surfaces of babaco leaves in greenhouses at the Agassiz Research Station in December, 1989 (Fig. 1). As the disease progressed, many colonies were formed on some leaves but compared to *Sphaerotheca fuliginea* on cucumber or *Erysiphe graminis* on wheat or barley, production of conidiophores and conidia was sparse (Fig. 2). Heavy infection caused a premature yellowing of leaves and eventual leaf abscission: however, the pathogen spread slowly and the pruning of severely infected leaves prevented serious yield losses. The pathogen was observed to be restricted to the leaves which is similar to the observation of powdery mildew of babaco made by Boesewinkel (1982b). As the season progressed, infection gradually diminished, until in early April, the pathogen was no longer observed. It would appear that during the spring, the greenhouse daily temperature increased and the pathogen was unable to maintain itself.

Despite the apparent lack of negative effects of the powdery mildew on babaco, the possibility that it was the same powdery mildew that infects cucumber [*Sphaerotheca fuliginea* (Schlecht.: Fr.) Poll. and *Erysiphe cichoracearum* DC: Merat] was cause for concern. If babaco could act as an alternative host, the pathogen could survive the winter and subsequently infect young cucumber plants which are normally planted in late December or early January in commercial greenhouses. It was therefore important to identify the causal agent of the powdery mildew infecting the babaco.

Materials and methods

The sexual state of the powdery mildew pathogen was not observed to form on infected babaco tissue, so the asexual state had to be used for identification. To examine the morphological characteristics of the pathogen, 8 infected leaf pieces from 4 plants were sampled, decolourized in boiling 90% ethanol, and cleared for a minimum of 48 hours in saturated chloral hydrate. The cleared leaf pieces were mounted in Hoyers medium and viewed using a Zeiss Axioplan Universal transmitted light microscope equipped with differential interference contrast optics. Measurements were made to determine the sizes of hyphal cells, haustoria, conidiophores and conidia, the shapes of conidia, conidiophores and hyphal appressoria.

Fresh live conidia were mounted in 3% KOH and examined microscopically to determine the presence or absence of internal fibrosin bodies (Boesewinkel 1980). To examine

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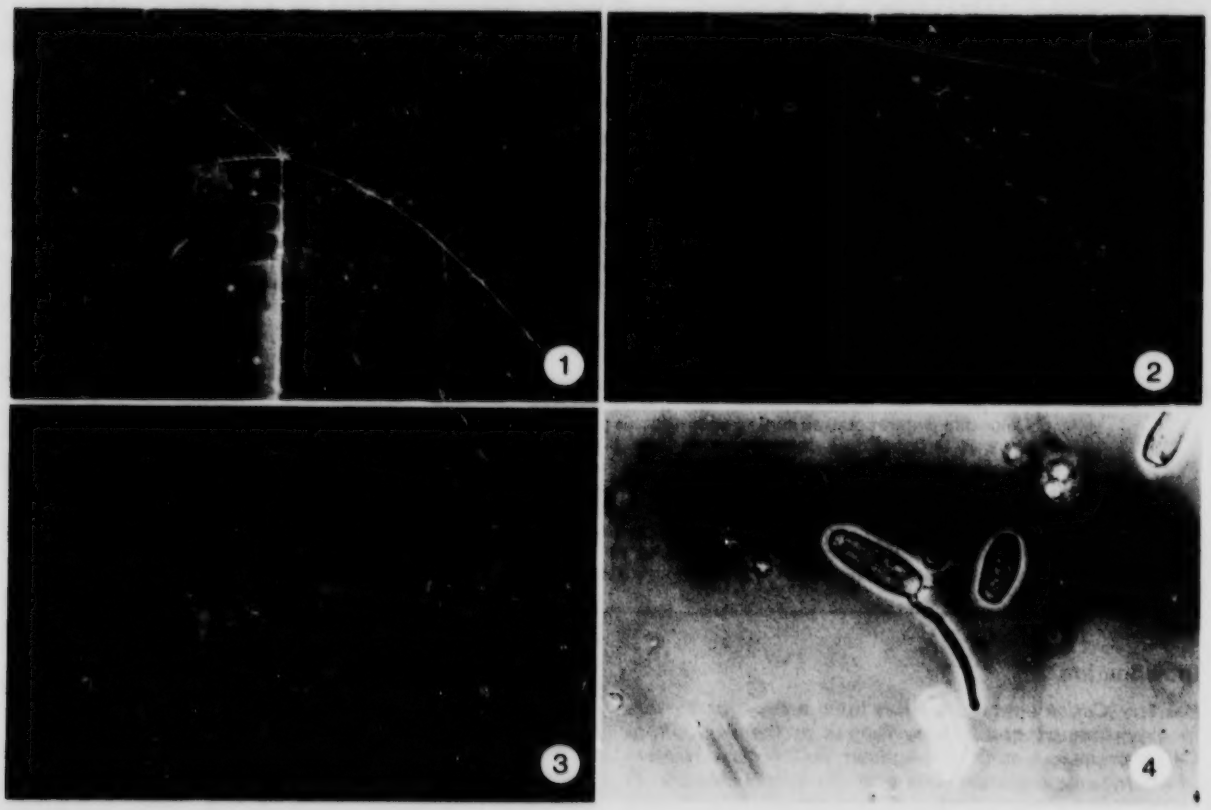

Fig. 1. A babaco leaf with colonies of the powdery mildew pathogen.

Fig. 2. A powdery mildew colony on a babaco leaf showing sparse conidiophore production.

Fig. 3. Short chains of conidia produced by the powdery mildew pathogen.

Fig. 4. A germinating conidium of the babaco powdery mildew pathogen.

the development of the germ tube and appressoria, fresh conidia were inoculated onto 5 glass slides by pressing colonies of the pathogen onto the slides. The inoculated slides were then incubated at 20°C in the dark in individual petri dishes containing a few drops of water. After 24 hours, the conidia were mounted in Hoyer's medium for microscopic examination of the germ tubes and appressoria. Fifteen conidia were examined per glass slide.

Four young seedlings of cucumber (*Cucumis sativus* L.), Kohlrabi [*Brassica oleraceae* var. *gongylodes* L.] and radish (*Rhaphanus sativus* L.) were grown to the expansion of the first true leaf. The first leaf of each seedling was inoculated with conidia of the babaco pathogen by pressing colonies on infected babaco leaves onto the seedling leaves. Plants were examined for symptoms of infection after 2 to 3 weeks of incubation in a greenhouse containing babaco plants infected with the powdery mildew pathogen.

Results

Results of our examinations of the asexual state of the pathogen revealed that hyphal cells (n=24) were (36)-62-(95) X (4)-5-(5)µm, and the hyphae possessed moderately lobed appressoria. Haustoria (n=32) were unlobed globose to pear-shaped and (13)-18-(21) X (9)-14-(23)µm. Conidiophores (n=40) arose from unspecialized foot cells, (23)-34-(48) X (5)-7-(10)µm (Table 1), were unbranched and composed of 3 cells. The size of conidiophore was (55)-71-(100) X (5)-7-(10)µm. Conidia were borne in short chains on the conidiophores (Fig. 3) and the smooth walled conidia (n=80) were (10)-16-(20) X (30)-44-(55)µm. Fibrosin bodies were not detected after mounting the conidia in 3% KOH (Boesewinkel 1980). Straight germ tubes arose from the end of the conidia (n=75) and ended in a slightly enlarged bulbous appressorium (Fig. 4). Inoculation of the cucumber, kohlrabi and radish plants with conidia did not result in symptoms of powdery mildew.

Table 1. Morphological characteristics of powdery mildew fungi reported to infect babaco[1].

Morphological characteristic	Babaco Mildew at Agassiz	*Oidium caricae-papayae* Yen	*Sphaerotheca fuliginea* (Schlecht.:Fr.) Poll.	*Oidium caricae* Noack[2]	*Oidium caricae* Noack[3]	*Oidium caricae* Noack[4]	*Oidium caricae* Noack[5]	*Erysiphe cichoracearum* DC ex Merat	*Erysiphe cruciferarum* OPIZ ex JUNELL
Conidia	short chains (40)-34-(25) X (15)-13-(12.5)	short chains 36-48 X 15.6-19	long chains 25-37 X 14-25	23-25 X 14.5-20	borne singly 40-51 X 10-16	38-51 X 16-20	long chains 26-36 X 15-20	long chains 25-45 X 14-26	borne singly 42-50 X 16-18
Fibrosin bodies	inconspicuous	inconspicuous	conspicuous	inconspicuous	inconspicuous	inconspicuous	conspicuous	inconspicuous	inconspicuous
Conidiophores	2 septate (100)-70-(55) X (10)-7-(5)	60-160 X 13.2-18	80-100		0-2 septate		0-2 septate 58-80 X 10-13	75-160 X 10-12.5	0-2 septate 70-85 X 8-9
foot cell	(23)-34-(48) X (10)-7-(5)	36-55 X 8.4-12							
Germtubes	arise at end of conidium, staight, inconspicuous appressorium	arise at end of conidium,	arise at side of conidium, forked tube, inconspicuous appressorium					arise at end of conidium, staight, inconspicuous appressorium	arise at end of conidium, forked tube inconspicuous appressorium
Hyphal appressoria	moderately lobed	moderately lobed	unlobed		multilobed			unlobed	multilobed

[1] Reports of powdery mildew fungi infecting babaco and descriptions of these fungi were obtained from Boesewinkel 1977, 1980, 1982a, 1982b, Yen 1966, Tanda and Braun 1985 and Kapoor 1967a, 1967b. All measurements are in µm.

[2] Noack 1898, as referred to by Boesewinkel 1982a.

[3] Boesewinkel 1982a, teleomorph stated as *Erysiphe cruciferarum* OPIZ ex JUNELL.

[4] Yen 1966.

[5] Tanda and Braun 1985, teleomorph stated as *Sphaerotheca caricae-papayae* Tanda & U. Braun.

Discussion

Asexual morphological characteristics of powdery mildew pathogens have been used for identification in cases where the sexual state is not observed (Boesewinkel 1977, 1980). Boesewinkel (1980) lists the most important characteristics for identification of the asexual state of powdery mildew fungi as the presence or absence of conspicuous fibrosin bodies, shape of hyphal appressoria, size and shape of conidiophores and conidia, and the production of conidia in chains or singly.

Powdery mildew on babaco has previously been reported to be caused by *Oidium caricae* Noack (Boesewinkel 1982a), *E. cichoracearum* DC ex Merat, and *Sphaerotheca fuliginea* (Schlecht. ex Fr.) Poll. (Boesewinkel 1982b). Using the key to species of the Erysiphaceae based on the morphology of imperfect states by Boesewinkel (1980), the pathogen on babaco at Agassiz was identified as *Oidium caricae-papayae* Yen. However, *O. caricae* was not listed in this taxonomic key. Descriptions of *O. caricae* were obtained from Boesewinkel (1982a), Yen (1966) and Tanda and Braun (1985) (Table 1) for comparison with those of the pathogen observed at Agassiz, and with the description of *O. caricae-papayae* by Boesewinkel (1980). Unfortunately, the descriptions of *O. caricae* are not complete and there is some disagreement among the descriptions. For example, different sexual states have been attributed to *O. caricae* (Table 1). Nevertheless, it appears that the morphological characteristics of *O. caricae-papayae* Yen listed by Boesewinkel (1980) gives the best match to the characteristics of the babaco pathogen observed at Agassiz.

The identity of the host plant can also be useful in identifying a powdery mildew pathogen but can lead to misidentification when plants can be infected with more than one powdery mildew. The lack of infection of cucumber, radish and kohlrabi when inoculated with conidia of the babaco pathogen was helpful in identifing the pathogen, since it helped determine that the pathogen is not the crucifer pathogen *E. cruciferarum*. The lack of formation of powdery mildew colonies on cucumber seedlings confirmed that the babaco powdery mildew pathogen is neither of the two cucumber powdery mildew pathogens, *Erysiphe cichoracearum* or *Sphaerotheca fuliginea*. This was re-confirmed by observations in the greenhouse where high populations of the powdery mildew fungus were observed on babaco but not on neighbouring cucumber plants. As well, in other greenhouse ranges, cucumber plants heavily infected with powdery mildew have been grown next to babaco plants that did not show signs of powdery mildew infection. It appears that greenhouse cucumber growers do not have to be concerned about the babaco powdery mildew pathogen.

Literature cited

1. Boesewinkel, H.J. 1977. Identification of Erysiphaceae by conidial characteristics. Rev. Mycol. (Paris) 41:493-509.
2. Boesewinkel, H.J. 1980. The morphology of the imperfect states of powdery mildews (Erysiphaceae). Bot. Rev. 46:167-224.
3. Boesewinkel, H.J. 1982a. The identity of *Oidium caricae* and the first recording on papaya, mountain papaya and babaco in New Zealand. Fruits (Paris) 37:473-477.
4. Boesewinkel, H.J. 1982b. Babaco, mountain papaya and papaya: all are susceptible to powdery mildew. N.Z. J. Agric. 145:28.
5. Dawes, S.N. and G.J. Pringle. 1983. Subtropical fruit from South and Central America. Page 136 In: Plant Breeding in New Zealand. G.S. Wratt and H.C. Smith (Eds.). Butterworths of New Zealand Ltd., Wellington, New Zealand.
6. Kapoor, J.N. 1967. *Sphaerotheca fuliginea*. C.M.I. Descriptions of Pathogenic Fungi and Bacteria No. 159. C.M.I. Kew, Surrey, England. 2pp.
7. Kapoor, J.N. 1967. *Erysiphe cichoracearum*. C.M.I. Descriptions of Pathogenic Fungi and Bacteria No. 152. C.M.I. Kew, Surrey, England. 2pp.
8. Tanda, S. and U. Braun. 1985. Two new powdery mildew fungi on *Carica papaya* and *Phyllanthus flexuosus*. Trans. Mycol. Soc. Jpn. 26:315-319.
9. Yen, W.Y. 1966. Étude sur les champignons parasites du Sud-Est asiatique VI: Un nouvel *Oidium* récolte a Taiwan (Formose) sur *Carica papaya*: *Oidium caricae-papayae* Yen (n. sp.). Rev. Mycol. (Paris) 37:125-153.

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Diagnostic laboratories / Laboratoires diagnostiques

Crop / Culture: Cultures aux fruits

Location / Emplacement: Québec

Title / Titre: Maladies des petits fruits et du pommier identifiées par le laboratoire de diagnostic en 1990

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METHODES: Le laboratoire de diagnostic a reçu quelque 1 580 échantillons pour l'identification de désordres observés sur diverses plantes cultivées. Les petits fruits et le pommier représentaient 18,9% des cas soumis. Plus spécifique, le fraisier comptait pour 9,7% des échantillons, le framboisier 4,9%, le bleuet 0,9% et le pommier 3,4%.

L'identification des maladies fongiques et bactériennes est réalisée par l'observation microscopique, l'isolement sur des milieux de culture sélectifs et la réalisation de tests biochimiques.

RESULTATS: Fraisier - parmi les principaux problèmes observés, 45 étaient de la stèle rouge (Phytophthora fragariae), 14 de la pourriture noire des racines (Idriella, Pyrenochaeta et/ou Rhizoctonia), 3 du flétrissement verticillien (Verticillium sp.), 6 de la tache commune (Mycosphaerella fragariae), 3 de la tache angulaire (Xanthomonas fragariae), 17 du gel hivernal et 8 des carences minérales diverses.

Framboisier - les principaux problèmes ont regroupé 14 échantillons de pourridié des racines (Phytophthora sp.), 4 de brûlure des dards (Didymella applanata), 2 d'anthracnose (Elsinoe veneta), 1 de brûlure bactérienne (Erwinia amylovora), 4 de maladies virales, et 21 de gel hivernal.

Pommier - les désordres regroupaient 9 cas de brûlure bactérienne (Erwinia amylovora), 4 de dépérissement nectrien (Nectria annalavina), 2 de flétrissement verticillien (Verticillium sp.), 9 de gel hivernal, et 2 de tache amère.

Crop / Culture: Canola

Location / Emplacement: Manitoba

Title / Titre: Diseases diagnosed on canola samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

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METHODS: There were 126 samples of canola submitted to the Manitoba Agriculture Plant Pathology Laboratory between January 1 and November 30, 1990. Samples were examined for symptoms of disease and when necessary, isolations were made on Potato Dextrose Agar.

RESULTS: Diseases diagnosed on canola are presented in Table 1. Blackleg (Leptosphaeria maculans) was the most common infectious disease problem and was diagnosed on 40 samples. The majority of these samples were from western Manitoba. Rhizoctonia root rot (Rhizoctonia solani) was found on 8 samples and was particularly severe on 2 samples submitted from Roblin. Downy mildew was found on 6 samples. The infections had occurred on plants during June, at which time the weather was very moist. Stem rot (Sclerotinia sclerotiorum) was found in only 4 samples and generally occurred at low levels throughout Manitoba. There were a large number of samples (45) in which herbicide injury (primarily due to spray drift), was the problem diagnosed.

TABLE 1: Diseases diagnosed on canola samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Blackleg	Leptosphaeria maculans	40
Root rot	Rhizoctonia solani	8
Downy mildew (early infection on leaves)	Peronospora parasitica	6
Stem rot	Sclerotinia sclerotiorum	4
White leaf spot	Pseudocercosporella capsellae	3
Herbicide injury		45
Nutrient deficiency (mainly sulphur)	sulphur deficiency	10
Environmental stress		6
Miscellaneous		4
Total		126

Crop / Culture: Fruit Crops

Location / Emplacement: Manitoba

Title / Titre: Diseases diagnosed on fruit crops submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

Name and Agency / Nom et Organisation: Platford, R.G.
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METHODS: There were 284 samples of fruit crops submitted to the Manitoba Agriculture Plant Pathology Laboratory. The majority of the saskatoons, raspberry, and strawberry samples were from commercial growers, while the apple, plum, pear, and currant samples were from home gardens.

RESULTS: Plum - of 41 samples of plum, 14 were affected by plum pocket (Taphrina communis), 3 by cytospora canker (Cytospora spp.), 1 by shot hole (Coccomyces spp.), 4 showed environmental stress and 19 were affected by miscellaneous problems including herbicide injury, insect damage, and nutrient deficiencies.

Currant - of 12 samples submitted, 2 were affected by powdery mildew (Sphaerotheca mors-uvae), 1 by anthracnose (Drepanopeziza spp.), 1 by leaf spot (Mycosphaerella ribis), 1 by canker (Nectria cinnabarina), 6 by physiological/ environmental causes, and 1 by herbicide injury.

Saskatoon - of 14 samples of saskatoon , 2 were found to be affected by leaf spot (Entomosporium maculatum), 1 with rust (Gymnosporangium spp.), 1 canker (Valsa sp.), 7 environmental (winter injury), and 4 miscellaneous including herbicide and insect injury.

Pear - of 12 samples submitted, 2 showed fireblight (Erwinia amylovora), 2 frogeye leaf spot (Botryosphaeria obtusa), 4 showed effects of winter injury, and 4 were affected by nutrient deficiencies and herbicide injury.

Apple - of 126 samples submitted, 46 showed fireblight (Erwinia amylovora), 16 cytospora canker (Cytospora spp.), 10 frogeye leaf spot (Botryosphaeria obtusa), 3 silverleaf (Chondrostereum purpureum), 1 white rot (Botryosphaeria dothidea), 34 environmental damage (winter injury), 12 nutrient deficiency (iron chlorosis), and 4 samples showed herbicide drift injury.

Raspberry - of 45 samples submitted, 12 were found to be affected by anthracnose (Elsinoe veneta), 10 by cane blight (Leptosphaeria coniothyrium), 3 by fireblight (Erwinia amylovora), 1 with powdery mildew (Oidium spp.), 1 with fruit rot (Botrytis spp.). In addition to infectious disease, 2 samples were affected by winter injury causing tip kill and 11 samples showed nutrient deficiency, primarily iron chlorosis, and 5 showed environmental stress.

Strawberry - of 34 samples submitted, 16 were affected by crown and root rot (Fusarium spp.), 7 by fruit rot (Botrytis cinerea), 4 by leaf spot (Mycosphaerella fragariae), 1 by powdery mildew (Sphaerotheca macularis), 1 by suspected virus disease, 5 by physiological disorders as a result of environmental stress, and 14 samples exhibited insect damage.

Crop / Culture: Forage Crops

Location / Emplacement: Manitoba

Title / Titre: Diseases diagnosed on forage samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

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METHODS: There were 20 samples of forage crops submitted to the Manitoba Agriculture Plant Pathology Laboratory.

RESULTS: Results of forage submissions are presented in Table 1. Winter kill was severe in some fields because of poor snow cover and cold temperatures in early December Spring black stem and its associated leaf spot was the most common problem identified on alfalfa. Crown rot continues to be a major problem in stands over 4 years old. Observations suggest a relationship between winter injury, snow mould and invasion of damaged alfalfa crowns by *Fusarium* spp.

TABLE 1: Diseases diagnosed on forage samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Spring black stem	*Phoma medicaginis*	8
Physiological	Winter injury, white spot	5
Crown rot	*Fusarium* spp.	4
Herbicide injury		4
Common leaf spot	*Pseudopeziza medicaginis*	3
Downy mildew	*Peronospora trifoliorum*	1
Yellow leaf blotch	*Leptotrochila medicaginis*	1
Stemphylium leaf spot	*Stemphylium botyosum*	1
Total		27

Crop / Culture: Shade Tree

Location / Emplacement: Manitoba

Title / Titre: Diseases diagnosed on samples of shade trees submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

Name and Agency / Nom et Organisation: Platford, R.G.
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METHODS: Over 500 samples of trees and shrubs were submitted to the laboratory in 1990, not including 1,811 samples of elms submitted for Dutch Elm Disease analysis. Samples were examined for symptoms of diseases and when necessary, isolations were made onto Potato Dextrose Agar. Following are diseases and disorders most commonly diagnosed.

RESULTS: Poplar (*Populus* spp.) - In 40 samples of poplar, 4 showed cytospora canker (*Cytospora chrysosperma*), 4 septoria canker and leaf spot (*Septoria musiva*), 7 leaf rust (*Melampsora medusae*), 2 shoot blight (*Pollacia* spp.), and 7 samples showed effects of environmental stress. In addition to disease, 15 samples were submitted with insect injury.

Oak (*Quercus macrocarpa*) - In 32 samples of oak, 2 showed anthracnose (*Gnomonia veneta*), 4 leaf blister (*Taphrina caerulescens*), 1 phomopsis twig canker (*Phomopsis* spp.), 5 showed oak decline due to the environmental stress of drought and site disturbance, and 1 canker (*Fusarium solani* and *F. oxysporum*). In addition to diseases, 19 samples showed insect injury.

Spruce (*Picea* spp.) - In 95 samples of spruce, 17 showed cytospora canker (*Cytospora kunzei*), 2 showed needle cast (*Rhizosphaerea kalkhoffii*, *Lirula* spp.), 39 showed environmental stress due to drought stress, 1 showed seedling blight (*Fusarium* spp. and *Botrytis cinerea*), 4 showed herbicide injury. In addition to disease, 30 samples showed insect damage.

Scots Pine (*Pinus sylvestris*) - In 14 samples of pine, 1 showed western gall rust (*Endocronartium harknessii*), 1 showed needle cast (*Cyclaneusma niveum*), 2 showed canker (*Cytospora* spp.), 7 showed environmental stress, 1 showed mechanical damage, 1 herbicide injury and 1 insect damage.

Birch (*Betula* spp.) - In 40 samples of birch, 17 showed birch dieback (complex of environmental stress, nutrient deficiency and bronze birch borer damage), 3 showed cytospora canker (*Cytospora* spp.), and 2 showed herbicide injury. In addition to diseases, 18 samples showed insect damage.

Ash (*Fraxinus* spp.) - In 48 samples of ash, 3 showed anthracnose (*Gloeosporium* spp.), 2 showed canker (unidentified cause), 8 showed effects of the environmental stress of winter injury and drought. In addition to infectious disease, 21 samples showed symptoms of herbicide injury, and 14 samples exhibited insect damage.

Manitoba Maple (*Acer negundo*) - In 68 samples of maple, 11 showed cytospora canker (*Cytospora* spp.), 4 showed anthracnose (*Gloeosporium* spp.), 1 showed steganosporium canker (*Steganosporium* spp.), 15 showed environmental stress primarily leaf scorch due to drought conditions, 23 samples showed leaf distortion due to herbicide drift, 8 showed nutrient deficiency, and 5 showed insect damage.

Crop / Culture: Turfgrass

Location / Emplacement: Manitoba

Title / Titre: Diseases diagnosed on turfgrass samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990

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METHODS: There were 95 submissions of turfgrass sent to the Manitoba Agriculture Plant Pathology Laboratory in 1990. Samples were examined for disease symptoms and where necessary, isolations were made onto Potato Dextrose Agar.

RESULTS: Diseases diagnosed on turf submissions are presented in Table 1. Leaf diseases caused by Colletotrichum graminicola, Ascochyta spp, and Drechslera spp. were more prominent in Manitoba in 1990 than in 1989 primarily as a result of moist weather in June. Snow mold was not a major problem in 1990. Decline of lawns, attributed to Fusarium patch and late season drought conditions, was a frequent problem in 1990 diagnosed on lawn samples submitted from Winnipeg.

TABLE 1: Diseases diagnosed on turfgrass submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Anthracnose	Colletotrichum graminicola	25
Ascochyta	Ascochyta spp.	8
Melting out	Drechslera spp.	27
Fusarium patch	Fusarium spp.	11
Septoria	Septoria spp.	3
Pink snow mold	Gerlachia nivalis	2
Slime mould	Physarum spp.	2
Environmental stress	drought	6
Herbicide injury		4
Miscellaneous		7
Total		95

Crop / Culture: Diagnostic Laboratory Report

Location / Emplacement: British Columbia

Name and Agency / Nom et Organisation:
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Title / Titre: Diseases Diagnosed on Floriculture Crops in B.C., 1990.

METHODS: The B.C.M.A.F. Plant Diagnostic Lab provides the diagnosis of, and control recommendations for disease problems of commercial crops. The following data reflects samples submitted to the lab by Ministry extension staff, growers and agribusiness. Diagnosis was accomplished by microscope examination, culturing onto artificial media, ELISA and the Biolog bacterial identification system. Viruses were identified by Dr. R. Stace-Smith and Dr. D. MacKenzie, Agriculture Canada Research Station, Vancouver, through sap inoculation onto indicator plants and ELISA.

RESULTS AND COMMENTS: There were 153 submissions consisting of 60 floriculture plant species. Highlights of disease submissions on floriculture crops are presented in table 1. Root rots caused by *Pythium* or *Phytophthora* were the most common infectious disease, accounting for 22 submissions. Tomato spotted wilt virus was detected in 13 samples on cineraria, cyclamen, impatiens, marigold, petunia and primula. Bacterial blight was detected on 10 geranium samples. Physiological diseases were diagnosed on 30 submissions.

Table 1 Highlights of Floriculture Disease Submissions in 1990

Crop	Disease	No. of Samples
Alstroemeria	Crown and root rot (*Phytophthora* sp)	1
Anemone	Collar rot (*Botrytis cinerea*)	1
Anthurium	*Xanthomonas campestris pv. dieffenbachiae*	1
Cineraria	Tomato spotted wilt virus	3
Cyclamen	*Fusarium oxysporum f. sp. cyclaminis*	1
	Crown rot (*Erwinia carotovora*)	1
	Tomato spotted wilt virus	1
Carnation	*Fusarium oxysporum*	1
Freesia	*Stromatinia* dry rot	1
Geranium	Root rot (*Pythium* sp.)	7
	Xanthomonas campestris pv. pelargonii	8
Geranium, ivy	Root rot (*Pythium* sp.)	1
	Xanthomonas campestris pv. pelargonii	2
Impatiens	Tomato spotted wilt virus	1
Impatiens New Guinea	Leaf spot (*Pseudomonas* sp.)	1
	Tomato spotted wilt virus	5
Iris, bulbous	*Sclerotium rolfsii*	1
Kalanchoe	Root rot (*Thielaviopsis basicola*)	1
Marguerite	Tomato aspermy virus	1

Marigold	Tomato spotted wilt virus	1
Petunia	Root rot (*Thielaviopsis basicola*)	1
	Tomato spotted wilt virus	1
Poinsettia	Root rot (*Pythium* sp.)	5
	Stem rot (*Rhizoctonia* sp.)	1
	Branch wilt	4
Primula	Wilt (*Pseudomonas* sp.)	1
	Tomato spotted wilt virus	1
Ranunculus	Tomato spotted wilt virus	1
Syngonium podophyllium	*Xanthomonas campestris pv. syngonii*	1
Total		36

Crop / Culture: Diagnostic Laboratory Report

Location / Emplacement: British Columbia

Name and Agency / Nom et Organisation: MacDonald, Leslie S.
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Title / Titre: Diseases Diagnosed on Greenhouse Vegetable Crops in B.C., 1989 and 1990.

METHODS: The B.C.M.A.F. Plant Diagnostic Lab provides the diagnosis of, and control recommendations for disease problems of commercial crops. The following data reflects samples submitted to the lab by Ministry extension staff, growers and agribusiness. Diagnosis was accomplished by microscope examination, culturing onto artificial media and bioassays. Viruses were identified by Dr. R. Stace-Smith, Agriculture Canada Research Station, Vancouver, through sap inoculation onto indicator plants and ELISA.

RESULTS AND COMMENTS: Disease submissions on greenhouse vegetable crops are presented in table 1. *Pythium* root rot was the most common disease diagnosed on cucumber. Zucchini yellow mosaic virus was introduced for a second time into a B.C. greenhouse; the first incident was in 1988. Pepper mild mottle virus caused an estimated $1.2 million loss this year. Most of the loss occurred at three greenhouses where it was introduced early in the growing season and spread through crop handling before its presence was indicated by symptom development on the fruit. The tomato spotted wilt virus report for 1990 was from tomato transplants grown for the bedding plant market. Physiological diseases were the most common diagnosis on tomato crops with most related to imbalanced nutrient levels. The miscellaneous category refers to insect injury, undetermined cause and no disease as the diagnosis.

Table 1 Summary of Greenhouse Vegetable Crop Diseases Submitted in 1989 and 1990.

Crop	Disease	No. of Samples 1989	1990
Cucumber	Stem & fruit rot (*Botrytis cinerea*)	-	2
	Root rot (*Pythium* sp.)	6	6
	Damping off (*Rhizoctonia* sp.)	-	1
	Stem rot (*Sclerotinia sclerotiorum*)	-	1
	Zucchini yellow mosaic virus	-	1
	Pale fruit viroid	1	1?
	Miscellaneous	2	-
Pepper	Root rot (*Pythium* sp.)	1	-
	Damping off (*Rhizoctonia* sp.)	-	1
	Pepper mild mottle virus	-	4
	Physiological	1	5
	Undetermined	-	2
Tomato	*Alternaria solani*	-	1
	Stem rot (*Botrytis cinerea*)	2	1
	Leaf mould (*Fulvia fulvum*)	5	2
	Fusarium oxysporum f.sp. racidis-lycop.	2	1
	Root rot (*Pythium* sp.)	3	3
	Rhizoctonia sp.	-	1
	Sclerotinia sclerotiorum	-	1
	Pith decay	3	-
	Tomato spotted wilt virus	1	1
	Cucumber mosaic virus	1	1
	Physiological	2	12
	Miscellaneous	6	5
	Total	36	53

Crop / Culture: Diagnostic Laboratory Report

Location / Emplacement: British Columbia

Name and Agency / Nom et Organisation: MacDonald, Leslie S.
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Title / Titre: Diseases Diagnosed on Small Fruit and Grape Crops in B.C., 1990.

METHODS: The B.C.M.A.F. Plant Diagnostic Lab provides the diagnosis of, and control recommendations for disease problems of commercial crops. The following data reflects samples submitted to the lab by Ministry extension staff, growers and agribusiness. Diagnosis was accomplished by microscope examination, and culturing onto artificial media.

RESULTS AND COMMENTS: Disease submissions on small fruit and grape crops are presented in table 1. The fall of 1989 had an early freeze which caused damage to some growth that was still succulent. Spring 1990 had some late frosts that damaged blossoms of early flowering varieties. May and June were very wet which promoted foliar diseases and caused root damage due to saturated soils for prolonged periods. There were 74 submissions in these categories.

Table 1 Summary of Small Fruit and Grape Crop Diseases Submitted in 1990

Crop	Disease	No. of Samples
Blueberry	Twig dieback (*Botrytis cinerea*)	2
	Godronia canker (*Fusicoccum putrefaciens*)	5
	Powdery mildew (*Microsphaera* sp.)	1
	Mummyberry (*Monilinia vaccinii-corymbosi*)	1
	Bacterial blight (*Pseudomonas syringae*)	6
	Crown gall	3
	Frost injury	10
	Improper management	9
	Insect or mouse damage	5
Cranberry	Upright dieback (*Phomopsis vaccinii*)	1
Currant	White pine blister rust (*Cronartium ribicola*)	1
	Insect/No disease	2
Gooseberry	Canker (*Ascochyta* sp.)	1
Raspberry	Spur blight (*Didymella applanata*)	2
	Cold damage	1
	Sun scorch	2
	Saturated soil	8
	Insect damage	1
Strawberry	Black root rot complex	1
	Red stele (*Phytophthora fragariae*)	8
	Verticillium sp.	2
	Physiological	2
	Insect damage	1
Grape	Brown rot of cluster (*Monilinia* sp.)	1
Total		74

Cereals / Céréales

Crop / Culture: Barley

Location / Emplacement: Saskatchewan

Title / Titre: Saskatchewan Barley Disease Survey, 1990

Name and Agency / Nom et Organisation:

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METHODS: A co-operative provincial disease survey was conducted in 110 barley fields between flowering and soft dough growth stages. Barley fields within five areas of the province representing most of the crop districts were surveyed (Fig. 1). The minimum guidelines for surveying methods were to walk 20 paces into a randomly selected field, and assess disease on a sample of 10 plants. Diseases such as smut, ergot, take-all, and viruses were estimated for the percent incidence in either the plant sample or over the entire field. Common root rot was estimated by counting the number of plants in the sample that had lesions covering more than 50% of the sub-crown internode. Foliar diseases were assessed on a 0-9 scale (Couture 1980) that reflects the impression of disease levels in the lower, middle, and upper leaf canopies. Some diseased samples were plated on media to determine which pathogen was present although most diseases were identified by visual symptoms in the field.

RESULTS AND COMMENTS: Of the fields surveyed, 40 were 2-rowed, 21 were 6-rowed, and 49 were not classified as to type. The distribution, severity, and prevalence of the diseases found on barley are shown for each crop district in Table 1.

Net blotch, mostly the netted-form, was found in 86% of the fields at moderate severity levels. Scald and spot blotch were found in one third of the fields at slight levels of infection. Twenty percent of the fields were described as having unidentified leaf spots which reflected the difficulty in visually distinguishing among the spotted-form of net blotch, spot blotch, and physiological leaf spot. Septoria leaf blotch occurred in 15% of the fields at trace levels. All foliar diseases were most prevalent in the north and east-central crop districts which coincided with the areas having more moisture. The exception was the most northern half of crop district 9B where very dry conditions caused stunting, premature senescence, and head sterilty. Traces of stem rust of barley occurred in 12% of the fields. However, one field of 2-row barley in the south-east corner of the province had moderate levels of stem rust on all plants. Common root rot was observed in almost all fields with an average of 28% of the plants showing severe disease symptoms on the sub-crown internodes. Loose and covered smut, powdery mildew, BYDV, ergot, take-all, and bacterial blight were noted in the occasional field and barley stripe (1%) was found in one field in the south-west corner of the province.

REFERENCE:

Couture, L. 1980. Assessment of severity of foliage diseases of cereals in cooperative evaluation tests. Can. Plant Dis. Surv. 1:8-10

Figure 1. Crop districts and boundaries of barley fields surveyed in Saskatchewan, 1990.

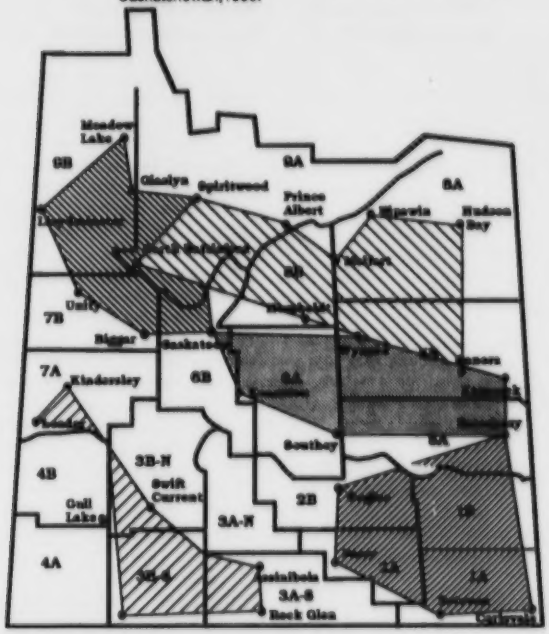

Table 1. Distribution, severity, and prevalence of barley diseases in Saskatchewan fields surveyed between flowering and soft dough stages, 1990.

Crop District	No. Fields	Leaf spot	Net blotch	Scald	Septoria	Spot blotch	Common root rot %	Smut %	Stem rust	Powdery mildew	BYDV %	Ergot %	Take all %	Bacterial blight
		*		**										
1A	3	1/1	7/2	-	-	-	20	1.1/3	TR/2	-	-	-	-	-
1B	2	3/1	5.5/2	2/1	-	-	30	-	SL/2	-	-	0.1/1	-	-
2A	1	-	-	-	-	-	90	-	-	-	-	-	-	-
2B	1	-	7/1	-	-	-	9	-	-	3/1	-	-	-	-
3A-N	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3A-S	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3B-N	2	-	3/2	-	-	-	45	-	-	-	1/1	-	-	-
3B-S	1	3/1	-	-	-	-	-	-	-	-	-	-	-	-
4A	0	-	-	-	-	-	-	-	-	-	-	-	-	-
4B	0	-	-	-	-	-	-	-	-	-	-	-	-	-
5A	5	2/1	6/4	6/1	2/1	-	37	-	TR/2	-	-	0.1/1	-	-
5B	15	1.6/4	4.6/15	0.8/3	0.8/3	1.6/5	19	-	TR/1	-	-	-	-	-
6A	2	4.5/1	-	1.3/2	-	-	25	-	-	-	-	-	-	-
6B	3	1/1	1/1	1/1	-	-	7	-	-	-	-	-	-	-
7A	4	1/4	1/1	1/1	-	-	27	-	-	-	1/1-	-	-	-
7B	2	8/1	5/2	1/1	-	-	53	-	-	-	5/2	-	-	-
8A	21	-	3.3/19	1.6/11	0.1/3	1.2/11	16	-	TR/3	-	-	-	-	-
8B	15	0.1/1	2.8/15	0.4/5	0.2/2	1.7/8	16	-	TR/3	-	-	-	-	-
9A	24	3/4	4.4/22	2.6/10	0.5/4	1.3/6	8	0.1/1	-	-	-	-	6/1	-
9B	9	4.5/2	3.9/8	5/3	5/1	-	24	2/1	-	-	-	-	-	1/2
Average or total	110	2.7/22	4.2/94	2.1/39	1.4/14	1.5/30	28	1.1/5	TR/13	3/1	2.3/3	0.1/2	1/1	1/2

* average disease rating (0-9 scale after Couture 1980) / number of fields affected

** not observed or not recorded

Crop / Culture: Barley

Location / Emplacement: Manitoba

Title / Titre: SURVEY FOR BARLEY LEAF DISEASES IN MANITOBA IN 1990

Name and Agency / Nom et Organisation:
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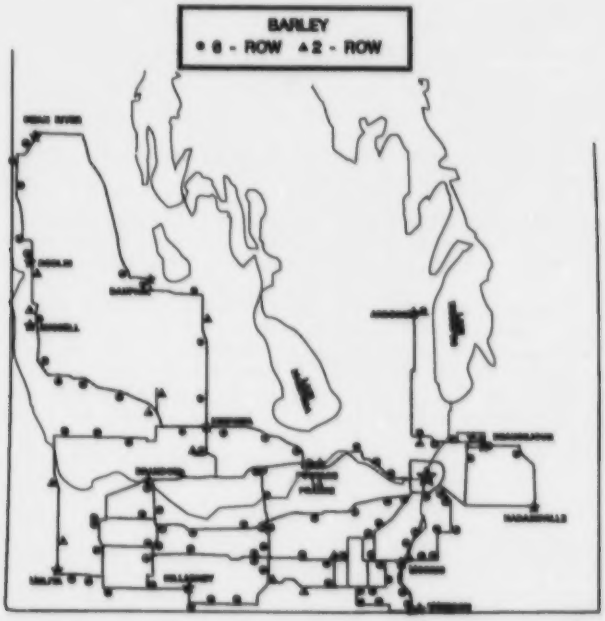
METHODS: Leaf disease incidence and severity levels were assessed by sampling 106 Manitoba barley fields between 11 July and 8 August. Fields were selected at random every 10-20 kms along the survey routes depending on crop frequency. Plants were examined along an inverted V transect approximately 50 m long per side. Disease levels were rated visually in both the upper (top 2 leaves) and lower canopies using a four-point scale: trace (<5% leaf area affected); slight (5-15%); moderate (16-40%); and severe (41-100%). Infected leaves were collected and kept in paper envelopes for subsequent pathogen identification and disease confirmation. Surface-sterilized tissue pieces were placed in moist chambers to promote pathogen sporulaton.

RESULTS AND COMMENTS: The location of the 95 six-rowed and 11 two-rowed fields surveyed is shown in Fig. 1. Growth stage at sampling ranged from 55 to 83 (Zadoks et al. scale). Disease level on upper leaves were generally trace or slight (a few moderate) and on lower leaves was largely moderate with 20% rated as moderate to severe. Pyrenophora teres (net blotch pathogen) was isolated from 92% of fields, and Cochliobolus sativus (spot blotch pathogen) from 71%. Most of the more severely diseased fields were of six-rowed barley infected with the net-form of net blotch. This may be a reflection of the susceptibility of Argyle barley (24% of acreage in 1990) to this form. Scald was detected in three fields and was moderate to severe in one field of six-rowed barley 25 km west of Shoal Lake. Overall, leaf diseases likely caused relatively little damage to the Manitoba barley crop in 1990. The general lack of rain after the first week of July prevented the spread and intensification of infection in the upper crop canopy. However, in some early-planted fields (of Argyle barley?), yield losses of about 25% are estimated, based on the disease severity observed.

Figure 1. Location of barley fields sampled for leaf diseases in Manitoba in 1990.



Crop / Culture: Barley, Oat and Wheat

Location / Emplacement: Central Alberta

Title / Titre: CEREAL DISEASE SURVEY IN CENTRAL ALBERTA - 1990

Name and Agency / Nom et Organisation:
D.D. Orr
Agriculture Canada
Research Station
Bag Service 5000
Lacombe, Alberta
T0C 1S0

METHODS: The cereal fields surveyed in central Alberta were selected at random in early August. Fields were traversed in an inverted V and plants were examined every 10 paces for root, leaf, and head diseases. Leaf diseases were rated as the percent leaf area affected. Head and systemic diseases were rated as the percent of plants affected in square metre samples. Root diseases were rated as the average severity of the disease in 10 plant samples.

RESULTS AND COMMENTS:

Weather Conditions: The 1990 growing season in central Alberta was characterized by heavier than normal rainfall in April, May and June. Many farmers had to delay seeding until the end of June. Continuing good growing conditions resulted in higher than average yields, however quality was reduced slightly, probably as a result of the elevated levels of leaf disease.

Two-Row Barley: Leaf diseases were once again prevalent in two-row barley, although at lower levels than in 1989. Approximately 60% of the fields with symptoms had penultimate leaves rating 10% or more for leaf disease. Net blotch (Pyrenophora teres) was present in all 18 fields examined, with one-third rating 10% or more damage on the flag leaf. Scald (Rhynchosporium secalis) occurred in two-thirds of fields with 50% of these rating 10% or more disease on the flag leaf. Loose smut (Ustilago nuda) occurred in 4 of the fields examined at levels of $\leq$ 1%. Covered smut (U. hordei) was noticed in only one field and barley yellow dwarf in 2 fields, both at levels of $\leq$ 1%. Fourteen of the fields showed common root rot symptoms (Cochliobolus sativus and Fusarium spp.) with 60% of these exhibiting disease levels of 10%.

Six-Row Barley: Leaf disease incidence was lower and less severe in the 19 fields of six-row barley examined. Only 36% of the fields infected with net blotch had disease ratings of 10% or more on the penultimate and no fields had more than 5% disease on the flag leaf. Scald occurred less frequently but the levels were higher. Ratings of 10% or more scald were found on 54% of the penultimate and 33% of the flag leaves. Covered smut was not found, but one-third of the fields had loose smut ratings of $\leq$ 1%. Common root rot was detected in 10 fields, with 7 having 5% and 1 field with 25% disease. Bacterial blight was present in three fields at very low levels. An interesting and unusual observation was that of two plants infected with barley leaf stripe (Pyrenophora graminea) in a field near Delburne. This is one of the few occurrences of leaf stripe in a commercial field in this area.

Oats: The four fields of oats surveyed all had very low disease levels. Septoria leaf blotch (Septoria avenae) was found in the lower leaf canopy in amounts of 5%. Blast symptoms were evident in three fields at 1% or less severity, which is about average. Barley yellow dwarf was seen at low levels in one field.

Wheat: Septoria leaf blotch (Septoria spp. complex) was the most prevalent disease and was found in 12 of the 14 fields surveyed. Disease severity was moderate with 80% of the penultimate and 8% of the flag leaves rating $\geq$ 10% disease. Take all (Gaeumannomyces graminis) occurred in half of the fields, with three having levels of 1%. Less than half of the fields surveyed had common root rot, all of them with $\geq$ 5% disease levels. Half the fields had leaf rust (Puccinia recondita) at very low levels and powderly mildew (Erysiphe graminis) in moderate amounts in the lower leaf canopy.

Crop / Culture: Barley, Oat, and Wheat

Location / Emplacement: Manitoba and Saskatchewan

Title / Titre: CEREAL SMUT SURVEY, 1990

Name and Agency / Nom et Organisation:
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METHODS: In July, 1990 cereal crops were surveyed for Ustilago hordei, U. nigra, U. nuda, U. tritici, U. avenae, and U. kolleri in Manitoba and Saskatchewan. The northern area was covered by a route from Winnipeg-Saskatoon-Prince Albert-Swan River-Winnipeg and the southern area by trips north and south of Winnipeg and a route from Winnipeg-Weyburn-Indian Head-Yorkton-Winnipeg. Fields were selected at random at approximately 15 km intervals, depending on the frequency of the crops in the area. An estimate of the percentage of infected plants (i.e. plants with sori) was made while walking an ovoid path of approximately 100 m in each field. Levels of smut greater than trace were estimated by counting plants in a 1 m^2 area at at least two sites on the path. U. nuda and U. nigra were differentiated by observing germinating teliospores with a microscope.

RESULTS: See Table 1. Smut was found in 72% of the fields of barley, 15% of the common wheat, 68% of the durum and 8% of the oat. The average levels were 0.6% for barley, 0.3% for durum wheat and trace for common wheat and oat. Noteable high incidences of smut observed were 10% U. nuda in fields of barley near Lucky Lake, SK and Grandview, MB, and 10% U. tritici in a durum field near Francis, SK.

COMMENTS: The average level of infection for barley was lower than for any year in the last decade. It is noteable that the incidence of the two seedling infecting smuts appears to have been reduced more by the drought of recent years than was the incidence of the floral infecting loose smut. The reason for this is not apparent. Most of the smut in common wheat was in fields that appeared to be sown to semi-dwarf types. The resistance in most of our wheat cultivars, and the drought, appears to be keeping the level of smut low. The 0.3% infection in durum wheat reflects resistance that is no better than fair in many cultivars. The trace level of infection in oat reflects good varietal resistance and the drought conditions of previous years.

TABLE 1. Incidence of smut in cereals in Manitoba and Saskatchewan in 1990

Crop	No. fields	Smut species	% Fields affected MB	% Fields affected SK	Mean % infected plants MB	Mean % infected plants SK
Common wheat	213	U. tritici	19	10	tr*	tr
Durum wheat	41	U. tritici	62	70	tr	0.7
Oat	39	U. avenae, U. kolleri	0	27	0	tr
Barley	202	U. nuda	77	51	0.5	0.4
		U. hordei	10	18	0.1	0.2
		U. nigra	14	1	0.1	tr

*tr = less than 0.1%

Crop / Culture: Cereals

Location / Emplacement: Maritime Provinces

Title / Titre: CEREAL DISEASE PROFILE IN THE MARITIME PROVINCES - 1990

Name and Agency / Nom et Organisation:

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Weather Conditions: Cereal production in the Maritimes was not adversely effected by fungal pathogens in 1990 as a result of the generally favorable weather patterns. The early portion of the planting season was relatively wet which delayed some seeding operations. Mid season conditions were dry in some areas and moisture may have limited yields. While post heading conditions were conducive to disease development in most of New Brunswick and Prince Edward Island, the stage of growth and rates of disease progression were slow and had little limiting effects on yield. Late season rains, particularly in New Brunswick, did have an impact on quantity and quality of the harvest. Western Nova Scotia was hot and dry and fungal diseases did not develop to significant severities.

Barley: Weather conditions during early and midseason were not conducive to the development of foliar disease. Foliar diseases of barley were not a serious problem in Nova Scotia or New Brunswick. Net blotch and scald, incited by Pyrenophora teres and Rhynchosporium secalis, respectively, were the primary barley diseases of concern in the Maritime Provinces. Scald was not a problem except on some early seeded fields. Net blotch was more severe than scald although relatively dry weather prior to heading resulted in little lesioning until late in the season. The lateness of the on-set of lesioning resulted in the yield losses from net blotch which were lower than normally expected for the region. Fusarium head blight of barley was not reported as being a problem although symptoms were identified at very low levels. Common root rot was observed in all areas but was not reported as being of any greater significance than in previous years. Loose smut remains a recurring problem in barley but at low levels. Excessive moisture at harvest time adversely effected the barley harvest in New Brunswick. Warm dry weather in Nova Scotia was not conducive to the development of disease outbreaks.

Wheat: In New Brunswick weather conditions were favourable for wheat production and fungal diseases were less severe than in most years. Late season storms caused some lowering of quality when harvests were delayed and through an increase in lodging. Fusarium head blight was not severe and septoria leaf and glume blotch were severe only with late harvested crops. On Prince Edward Island wheat had few disease problems with lower than normal levels of both fusarium head blight and septoria diseases. In only a few instances did the septoria leaf blotch reach a stage of severity that warranted use of a foliar fungicide. Wheat crops planted prior to mid-May rains were healthier than those planted after a 10-day period of wet weather. Tan spot incited by Pyrenophora tritici-repentis was commonly observed in research plots in Charlottetown. This pathogen forms a complex with Septoria nodorum on wheat leaves but no information is available on relative frequency of each from non-research fields. The severity of powdery mildew was low on both winter and spring wheats and varied in severity according to the resistance of the cultivar and N fertilization. Nova Scotia experienced a warm dry summer and fungal diseases did not develop on either winter or spring wheat to appreciable levels.

Oats: Diseases recorded on oats in the three Provinces were limited to Septoria avenae incited speckled leaf blotch which was less severe than usually found in the Maritime Provinces. A slight increase in BYDV may have occurred in New Brunswick.

Triticale: No fields of triticale were surveyed but research plots were healthy with no disease problems. Fusarium head blight was less severe than encountered with triticale in previous years.

Summary: The dry weather reduced the significance of diseases in 1990; however, this dry warm weather at heading and flowering was considered the cause of lowered grain yields in 1990.

Crop/Culture: Cereal Crops

Location/Emplacement: Manitoba

Title/Titre: Diseases diagnosed on wheat, barley and oat samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

Name and Agency/ Nom et Organisation:

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Methods: There were 222 samples of wheat, 173 of barley and 24 of oat sent to the Manitoba Agriculture Plant Pathology Laboratory in 1990. Samples were examined for disease symptoms, and where necessary, isolations were made onto Potato Dextrose Agar.

Results: Wheat - The results of the wheat submissions are shown in Table 1. Tan spot (Pyrenophora tritici-repentis) was the most commonly diagnosed disease. The samples were mainly submitted in June in which time the weather was very moist. Dry weather in July and August reduced the impact of tan spot and septoria blotch (Septoria spp.). Wheat streak mosaic virus disease was detected in 8 samples of spring wheat originating from McCauley and Minto in westhern Manitoba. In all cases these were of spring wheat that had been planted adjacent to winter wheat.

Barley - The results of the 173 barley submissions are presented in Table 2. Net blotch (Pyrenophora teres) was diagnosed in 53 samples. Its development was favoured by moist weather in June but dry conditions in July and August limited its further development. Barley yellow dwarf was severe in 1990, particularly on late planted barley. A flame chlorosis survey was conducted and 2 samples were sent into the laboratory. The results of the survey are presented separately. Stem rust (Puccinia graminis f. sp. tritici) was severe on 5 samples of late planted barley.

Oats - The results of the oat submissions are shown in Table 3. While only a single sample with crown rot (Puccinia coronata) was submitted crown rust of oats was the most prominent disease on the crops in 1990. The single sample submitted was from Vita in southeastern Manitoba and showed a rust severity greater than 50%. Barley yellow dwarf was also prominent on late planted oats as it was in barley and wheat.

TABLE 1. Diseases diagnosed on wheat samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990

Disease	Causal Agent(s)	Number of Samples
Tan spot	*Pyrenophora tritici - repentis*	72
Common root rot	*Cochliobolus sativus*, *Fusarium* spp.	29
Septoria	*Septoria* spp.	24
Glume blotch	*Septoria* spp.	11
Barley yellow dwarf	Barley Yellow Dwarf Virus	10
Wheat streak mosaic	Wheat Streak Mosaic Virus	8
Leaf rust	*Puccinia recondita* f. sp. *tritici*	6
Black chaff	*Alternaria* spp., *Cochliobolus* spp. *Cladosporium* spp.	3
Flame chlorosis	Flame Chlorosis Virus Like Agent	2
Take all root rot	*Gaeumannomyces graminis* var. *tritici*	1
Environmental stress	drought	33
Nutrient deficiencies		3
Herbicide injury		23

TABLE 2. Diseases diagnosed on barley samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990

Disease	Causal Agent(s)	Number of Samples
Net blotch	*Pyrenophora teres*	53
Barley yellow dwarf	Barley Yellow Dwarf Virus	37
Flame chlorosis	Flame Chlorosis Virus Like Agent	26
Common root rot	*Cochliobolus sativus*, *Fusarium* spp.	14
Stem rust	*Puccinia graminis* f. sp. *tritici*	5
Smut	*Ustilago* spp.	1
Environmental stress, Seeding problems		24
Herbicide		13

TABLE 3. Diseases diagnosed on oat samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990

Disease	Causal Agent(s)	Number of Samples
Barley yellow dwarf	Barley Yellow Dwarf Virus	7
Septoria blotch	*Septoria* spp.	4
Root rot	*Fusarium* spp., *Pythium* spp.	3
Bacterial blight	*Xanthomonas translucens*	2
Crown rust	*Puccinia coronata* f. sp. *avenae*	1
Wheat streak mosaic	Wheat Streak Mosaic Virus	1
Environmental stress		4
Herbicide injury		2

Crop / Culture: Oat

Name and Agency / Nom et Organisation:
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Location / Emplacement: Manitoba and eastern Saskatchewan

Title / Titre: OCCURRENCE OF OAT RUSTS IN WESTERN CANADA IN 1990

METHODS: The occurrence of oat crown rust (causal agent Puccinia coronata f. sp. avenae) and oat stem rust (causal agent P. graminis f. sp. tritici) in Manitoba and eastern Saskatchewan was determined by frequent examination of farm fields or stands of wild oat (Avena fatua L.) from early July to late August. Rust samples were collected from wild oat, cultivated oat, and rust nurseries located near Woodmore, Brandon, Morden, Dauphin, in Manitoba, and near Indian Head and Regina, in Saskatchewan.

RESULTS AND COMMENTS: Crown rust was first observed in trace amounts on wild oat in southern Manitoba on July 10. In the past several years crown rust was not observed in commercial fields, due to the widespread use of oat cultivars with both resistant genes Pc38 and Pc39 (Dumont, Riel, and Robert). In 1990 crown rust severities of 5% to 10% were commonly observed in commercial fields, indicating the widespread occurrence of crown rust races that can attack these resistant cultivars. To date 63 of the 147 isolates isolated from the 1990 field collections were races with virulences to both genes Pc38 and Pc39 and other Pc genes. Races with these virulences, first isolated in 1987, were more prevalent in 1990 than in 1989. If these races become established in Manitoba, significant crop losses are likely in future. Efforts are underway to incorporate additional resistance into well adapted cultivars such as Dumont and Robert.

Oat stem rust was first observed in trace amounts on wild oat in Manitoba on August 2, and did not develop significantly in Manitoba through to late August. All the oat cultivars currently grown in the eastern prairies are highly resistant to the predominant races of the stem rust population.

Crop / Culture: Oat

Location / Emplacement: Quebec

Title / Titre: A SUMMARY OF DISEASES OF OATS IN QUEBEC IN 1990

Name and Agency / Nom et Organisation:

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The incidence of oat diseases was examined in six different regions of Quebec in late July and early August in 1990. Growth stages at the time of assessments ranged from medium milk to soft dough. Speckled leaf blotch (Septoria avenae f.sp. avenae) occurred as usual throughout the province. It was severe on the most susceptible cultivars and moderate on the others. Crown rust caused by Puccinia coronata was present in trace amounts on the most susceptible cultivar at St-Hyacinthe and was moderate at LaPocatiere (Lower St. Lawrence). At Deschambault (central Quebec) it was the most severe disease on the crop and all cultivars except one suffered very severe damage. The cultivar not affected by crown rust was affected severely by speckled leaf blotch. Yellow dwarf virus (BYDV) was observed in light quantities at Pintendre (Quebec City district) and at Lennoxville (Eastern Townships). Stem rust (Puccinia graminis f.sp. avenae) and fusarium head blight (Fusarium graminearum) were not detected at any significant level.

Crop / Culture: Spring Wheat

Location / Emplacement: Region of St-Hyacinthe, Quebec

Title / Titre: SURVEY OF SPRING WHEAT DISEASES IN 1990

Name and Agency / Nom et Organisation:

Devaux, A.
Service de la phytotechnie
St-Hyacinthe, M.A.P.A.Q.
C.P. 480, St-Hyacinthe, Quebec J2S 7B8

METHODS: Three fields of the cultivar Max, and one of the cultivars Casavant, Katepwa, Laura, Laval 19, Messier, Mondor, Opal, and Robin were surveyed for leaf, root, stem, and head diseases at Zadoks et al.[1] growth stages 47, 59, and 77. The intensity of foliar diseases was assessed on 10-20 plants at 10 sites along a W transect in the fields. Samples of 10 plants were pulled out at each site at ZGS 77 to note stem and root diseases. Leaf diseases were evaluated before and at heading as a percentage leaf area affected on the whole plant using the Horsfall & Barratt grading system[2]. After heading, only the flag leaves were assessed. Head blight was measured on the percentage heads and spikelets affected on 50 heads chosen at random at four different sites in each field.

RESULTS AND COMMENTS: Table 1 shows the minimum-maximum percentage disease intensity recorded at growth stages 47, 59, and 77. At heading, tan spot (Pyrenophora tritici-repentis) was observed in all the fields with a maximum intensity of 4.0% leaf area affected on cultivar Casavant. Powdery mildew was observed on susceptible cultivars with a maximum intensity of 3.3 to 3.5% infected leaf area. After heading, tan spot was mixed with Septoria nodorum and affected a maximum of 10.6% of flag leaves of cultivar Casavant and from 2.6 to 5.9% of flag leaves of the other cultivars. Powdery mildew (Erysiphe graminis) affected up to 3.5% of cultivar Casavant and leaf rust (Puccinia recondita) up to 3.8% of cultivar Mondor. Slight stem necrosis on basal portion of stems affected up to 19.7% of the stems of cultivar Max and 11.1% of Roblin. Other cultivars had a maximum of 2.1% affected stems caused mainly by Bipolaris sorokiniana and some Fusarium sp. Fusarium head blight (F. graminearum) was noted on all cultivars with a maximum of 5.2% infected spikelets on cultivar Max and a minimum of 0.2% infected spikelets on Laura. Take-all was not observed in the nine fields surveyed.

Table 1. Prevalence and intensity of spring wheat diseases in the St-Hyacinthe region in 1990.

Growth stages[1]		spots	mildew	rust	necrosis	heads	spikelets
Before heading:	47*	0-3.3	0-3.3	0	-	-	-
Heading:	59*	2.3-4.0	0-3.5	0	-	-	-
After heading:	77**	2.6-10.6	0-3.5	0-3.8	0-19.7	1.9-18.9	0.2-5.2

[1]Zadoks et al. growth stages of cereals. 1974. Weed Res. 14(6): 415-421.
[2]Horsfall & Barratt grading system. 1945. Phytopathology 35(8): 655 (Abstr.).
*Disease assessment on all leaves.
**Disease assessment on flag leaves only.

Crop / Culture: Wheat

Location / Emplacement: Saskatchewan

Title / Titre: Saskatchewan Wheat Disease Survey, 1990

Name and Agency / Nom et Organisation:

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METHODS: A co-operative provincial disease survey was conducted in 254 wheat fields between flowering and soft dough growth stages. Most of the crop districts in the province were surveyed (Fig. 1). The minimum guidelines were to walk 20 paces into randomly selected fields, and assess disease on a sample of 10 plants. Diseases such as smut, ergot, take-all, and viruses were estimated for the percent incidence in either the plant sample or over the entire field. Common root rot was estimated by counting the number of plants in the sample that had lesions covering more than 50% of the sub-crown internode. Foliar diseases were assessed on a 0-9 scale (Couture 1980) that reflects the impression of disease levels in the lower, middle, and upper leaf canopies. Although most diseases were identified by visual symptoms in the field, some cooperators plated diseased samples on media to determine which pathogens were present. Leaves were stored dry and later washed for 1 h, surface disinfected for 1 min in 0.6% sodium hypochlorite (Javex), then rinsed three times with sterile distilled water. Leaf pieces 6 cm long were put on water agar (1.6%) containing 100 mg/L streptomycin sulfate and 50 mg/L vancomycin hydrochloride and incubated under blacklight (BL) light for 12 h alternating with 12 h dark at 20 C. Sporulation was observed after about one week.

RESULTS AND COMMENTS: Of the fields surveyed, there were 219 spring wheat, 34 durum, and one winter wheat. The distribution, severity, and prevalence of the diseases are shown by crop districts in the province (Table 1).

The most prevalent diseases were leaf spots (particularly tan spot and *Septoria* spp.) and leaf rust which occurred in 50% of the fields. The severity of leaf spots was moderate whereas leaf rust occurred in trace to slight amounts. Fifteen leaf samples collected from crop districts 5A, 5B, and 6A were plated and the major foliar pathogens were *Pyrenophora tritici-repentis* in 10 samples, *Septoria nodorum* in 6, and *S. tritici* in 6. Five of the 15 fields had combinations of 2 or all 3 pathogens present where as only *P. tritici-repentis* was found in 5, *S. nodorum* in 3, and *S. tritici* in 2. *P. tritici-repentis* and *S. nodorum* were found throughout these districts but *S. tritici* was found only in the eastern half.

Common root rot was present in most fields with an average of 14% of the plants showing severe symptoms on the sub-crown internode. Powdery mildew and glume blotch were observed in 15% of the fields and occurred at a low disease severity. These two diseases were most frequently observed in the northern part of the province. About 5% of the fields showed infections of wheat streak mosaic virus (south), loose smut (south-west), and BYDV (south-west and west-central). The incidence of loose smut ranged from 0.1% to 6% whereas the incidence of the viral diseases ranged from 0.3% to 2%. Other diseases noted were ergot, stem rust, and bacterial blight. In one isolated area in crop district 2B, 3% of the heads inspected in the sample had ergot. In this same area, 50% of the wheat samples brought to the Saskatchewan Wheat Pool elevators were downgraded due to ergot.

Heat and moisture stress affected 24% of the fields surveyed in crop districts 3, 4, and 7A to the point of causing stunting, premature leaf senescence, and floret abortion. An unusual condition found in 14% of the fields in these same districts was plants with stems bent at 90 degrees to the vertical and the cause was unknown. Generally insect problems were not noted but in crop districts 3, 4, and 7A white heads due to wheat stem maggots were observed in 41% of the fields and in crop district 8A grasshoppers and green bugs appeared to be especially severe.

REFERENCE:

Couture, L. 1980. Assessment of severity of foliage diseases of cereals in cooperative evaluation tests. Can. Plant Dis. Surv. 1:8-10

Figure 1. Crop districts and boundaries of wheat fields surveyed in Saskatchewan,1990.

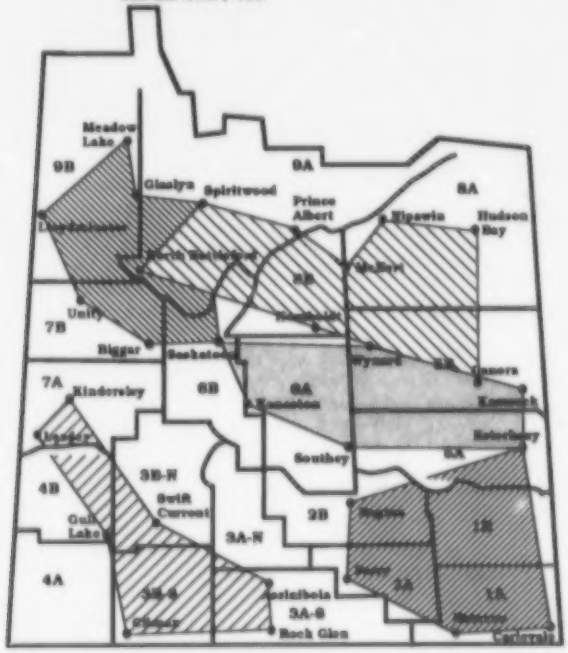

Table 1. Distribution, severity, and prevalence of wheat diseases in Saskatchewan fields surveyed between flowering and soft dough stages, 1990.

Crop District	No. Fields	Leaf spot	Tan spot	Septoria	Leaf rust	Common root rot %	Powdery mildew	Glume blotch%	Stem rust	WSMV	Ergot %	Smut %	BYDV %	Bacterial blight
		-*	**											
1A	6	-	4.5/6	3/1	1/3	26	-	1/1	TR/1	1/3	0.5/2	-	-	-
1B	8	-	5.4/8	3.5/2	2/8	16	-	-	-	1/3	0.1/2	0.1/1	-	-
2A	5	-	3.4/5	2/2	2/4	18	-	1/1	TR/1	-	-	-	-	-
2B	3	-	4.5/4	2.6/3	2/2	12	-	-	-	1/3	3/1	-	-	1.5/2
3A-N	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3A-S	7	2.7/7	-	-	1/2	10	1/1	-	-	-	-	0.1/3	-	-
3B-N	24	3.2/22	-	-	-	8	-	-	-	-	-	0.1/7	1/7	-
3B-S	13	2.5/11	-	-	1/2	9	4/2	-	-	-	-	0.1/2	2/5	-
4A	0	-	-	-	-	-	-	-	-	-	-	-	-	-
4B	14	1.4/9	-	-	-	26	-	-	-	-	-	3/2	2/3	-
5A	21	4/8	4.9/7	4.3/8	1/20	22	-	1/5	-	1/3	0.1/1	0.1/1	-	-
5B	33	3.7/10	4/19	5.1/23	1/10	12	0.7/5	-	-	-	-	-		
6A	18	2.8/18	-	-	1/16	20	-	-	-	-	-	-	1/1	-
6B	4	1/1	4/2	7/1	-	8	-	-	-	-	-	-	-	-
7A	7	2.2/5	-	-	1/1	20	-	-	-	-	-	-	0.3/4	-
7B	3	4/2	2/3	1/1	-	3	1/1	-	-	-	-	-	-	-
8A	18	-	3/17	3.2/15	0.9/10	10	2.5/12	1/6	-	-	-	-	-	-
8B	29	-	3.2/29	2.8/29	1.9/21	11	0.5/7	1/6	-	-	-	-	-	-
9A	32	5/2	3.4/28	4/28	0.2/4	6	1.2/12	1/10	-	-	-	-	-	-
9B	10	4.3/3	3.6/8	3.2/9	-	12	1/1	2/7	-	-	-	-	-	-
Aver. or total	254	3.1/98	3.8/136	3.5/122	1.2/103	14	1.4/41	0.8/36	TR/3	1/12	1/6	0.8/16	1.3/20	1.5/2

* not observed or not recorded

** average disease rating (0-9 scale after Couture 1980) / number of fields affected

Crop / Culture: Wheat

Location / Emplacement: Province of Quebec

Title / Titre: OCCURRENCE OF WHEAT DISEASES IN QUEBEC IN 1990

Name and Agency / Nom et Organisation:

Devaux, A.
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In 1990, the incidence of wheat diseases was recorded at nine locations in the six regions surveyed. Fusarium head blight (F. graminearum) was low to moderate in most regions but was most severe at Ste-Rosalie, Pintendre, and La Pocatiere. Leaf rust (Puccinia recondita) was severe on susceptible cultivars, late in the season, except at Lennoxville. Mixed leaf spot infections (Pyrenophora tritici-repentis and Septoria nodorum) were widespread in all regions but were less severe than usual this year. Powdery mildew (Erysiphe graminis) was present on susceptible cultivars in all regions except La Pocatiere, but milder at Normandin, Pintendre, and Deschambault. Glume blotch (Septoria nodorum) occurred in low intensities only at Lennoxville. (Ustilago nuda) and ergot (Claviceps purpurea) were observed only in trace quantities in southwestern Quebec.

Crop / Culture: Wheat

Location / Emplacement: Manitoba

Title / Titre: FOLIAR PATHOGENS OF WHEAT IN MANITOBA IN 1990

Name and Agency / Nom et Organisation:
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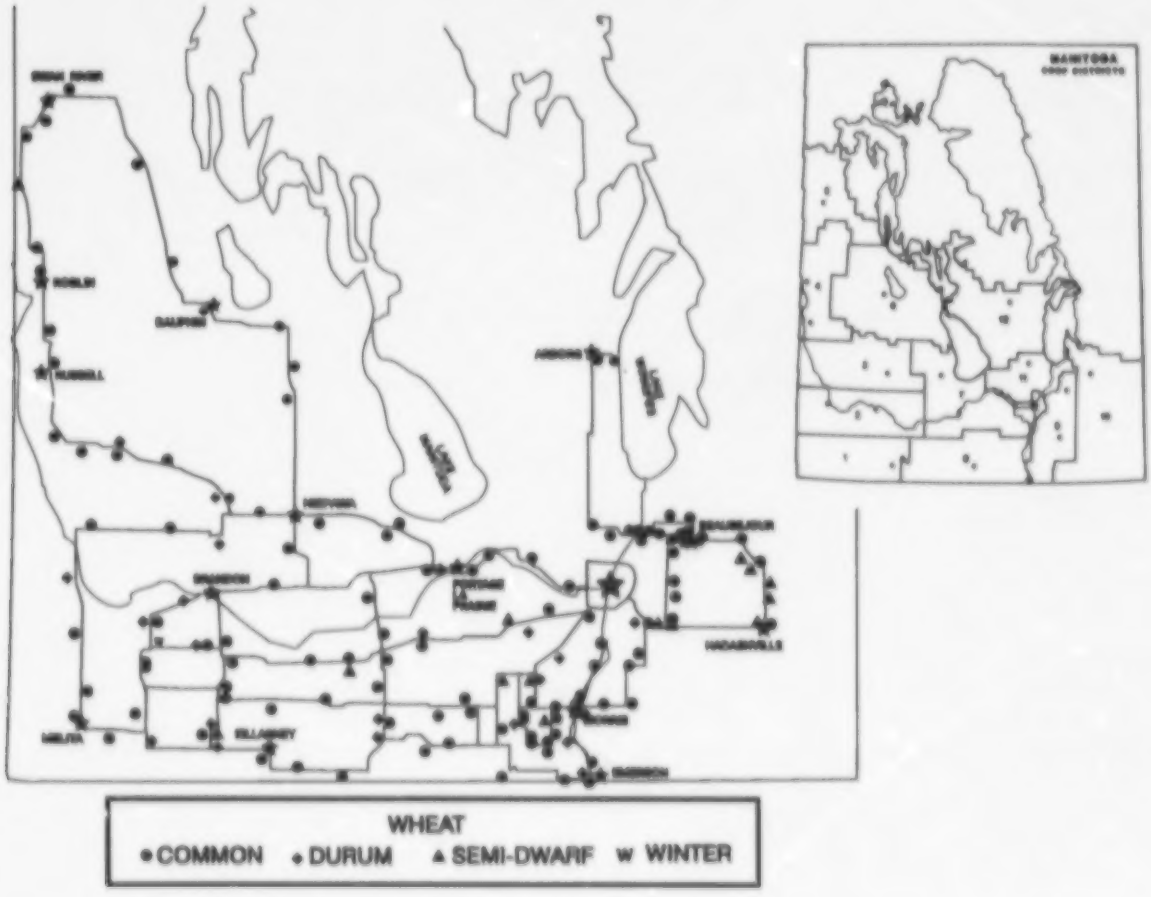
METHODS: One hundred and fifty-five fields of wheat (116 common, 22 durum, 16 semi-dwarf, and 1 winter) throughout the cereal-growing areas of Manitoba were surveyed for foliar pathogens from 11 July to 8 August 1990. Crop developmental stages were recorded at time of sampling and severity of disease on upper and lower leaves were categorized as 0, TR, 1, 2, 3, or 4, with 4 describing dead leaves and 1 lightly affected. Infected leaf samples were collected at each site for subsequent pathogen/disease determination. Lesions from leaf tissue were surface sterilized and placed in moisture chambers for 5-7 days to induce sporulation to facilitate pathogen identification.

RESULTS AND COMMENTS: Maturity of plants at sampling ranged from G.S. 57-83 (Zadoks et al. scale) with the majority between G.S. 65-75. The relatively wet spring caused more leaf-spotting in 1990 than in 1989 in Manitoba. Disease severity levels ranged from 0-2 on flag leaves and from 1-4 on lower leaves; in 36% of fields the latter were moderately to severely affected, or dead. Pyrenophora tritici-repentis (tan spot) was isolated from 83.9% of fields throughout the province (Table 1). Cochliobolus sativus (spot blotch), isolated from 72.3% of fields, was also widespread except in crop reporting district 5 (Swan River Region). Septoria leaf blotch (Septoria spp.) was found in 57.5% of fields, with the causal agent identified as S. nodorum in 46.5%, S. avenae f. sp. tritici in 9.7%, and S. tritici in 1.3%. Septoria was more common in crop reporting districts 7-11 in the south and east, and 5-6 in the north-west, than in other areas of the province. Leaf rust (Puccinia recondita) was evident in 33.5% of fields. Of these, 48.1% were moderately or severely affected. Infection levels were generally light in the south and the south-west, but moderate to severe in fields east of Winnipeg. Ascochyta tritici, causal agent of Ascochyta blight or leaf spot was isolated from 9.7% of fields. As was the case for most lesions of tan spot and Septoria, those of Ascochyta leaf spot could not be distinguished with certainty from the general "leaf spot complex".

Table 1. Frequency of diseases identified in 155 wheat fields in Manitoba in 1990.

Wheat Class	Disease						
	Septoria leaf blotch			Tan spot	Spot blotch	Leaf rust	Ascochyta blight
	"nodorum"	"avenae"	"tritici"				
Common	55	11	2	96	85	44	10
Durum	7	3	0	20	15	5	4
Semi-dwarf	9	1	0	13	12	3	1
Winter	1	0	0	1	0	0	0
Total	72	15	2	130	112	52	15
% Fields	46.5	9.7	1.3	83.9	72.3	33.5	9.7

Fig. 1. Wheat fields surveyed for foliar pathogens in 1990.



Crop / Culture: Wheat

Location / Emplacement: Manitoba

Title / Titre: OCCURRENCE OF FUSARIUM HEAD BLIGHT IN MANITOBA IN 1990

Name and Agency / Nom et Organisation:
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METHODS: One hundred and nineteen wheat fields throughout Manitoba were surveyed for Fusarium head blight between July 25 and August 13, 1990 by sampling an area of about 20 x 20 m at the edge of each field. Ten heads were collected from each field to confirm and identify the Fusarium species present.

RESULTS AND COMMENTS: At sampling time the crop developmental stage ranged from late milk to soft dough. Fusarium head blight was found in 74% of wheat fields examined and occurred throughout Manitoba (Fig. 1). It was found in 71% (60 of 85) of common, 100% (13 of 13) of durum and 71% (15 of 21) of semi-dwarf wheat fields. The severity ranged from trace (62 fields) to 20% heads infected. There were more common wheat fields having high severity levels in 1990 than in previous years. The severely infected wheat fields were found primarily in crop district 8 (south-central Manitoba). F. graminearum, F. poae and F. culmorum were the pathogen species isolated most frequently (Table 1).

Table 1. Distribution of Fusarium species in common, durum and semi-dwarf wheats in Manitoba in 1990.

	No. wheat fields			
	Common	Durum	Semi-dwarf	Total
F. graminearum	34	2	8	44
F. culmorum	19	5	2	26
F. poae	18	7	6	31
F. sporotrichioides	6	3	1	10
F. acuminatum	2	0	0	2
F. avenaceum	0	1	1	2

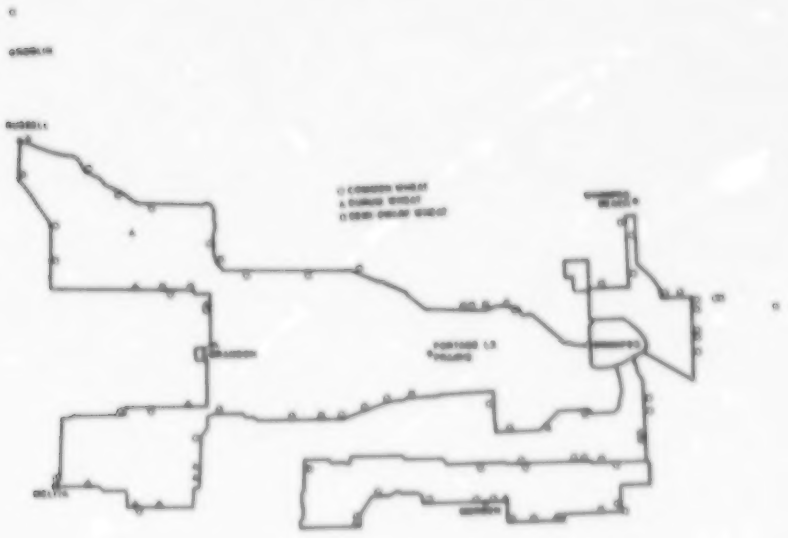

Fig. 1. Survey route and location of wheat fields positive for Fusarium head blight.

Crop / Culture: Wheat and Barley

Location / Emplacement: Manitoba

Name and Agency / Nom et Organisation:

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C. Platford
Manitoba Agriculture
Plant Pathology Laboratory
201-545 University Cres.
Winnipeg, MB R3T 5S6

Title / Titre: 1990 SURVEY OF FLAME CHLOROSIS IN MANITOBA

BACKGROUND Flame chlorosis (FC) is a novel, soil-borne, virus-like disease of spring cereals that has been reported only in Manitoba (1). Surveys carried out from 1986 to 1989 have indicated that the disease is most common in western Manitoba and appears to be spreading to other regions of the province (1,2). However, the 1986-1989 surveys were limited in their geographic extent, and did not examine systematically the level of FC within the fields that were surveyed. In 1990, a systematic and extensive survey for FC in barley and wheat was carried out with the co-operation of Manitoba Agriculture extension personnel.

METHODS Flame chlorosis is readily diagnosed between the seedling and 4-node stages of growth on the basis of its striking and characteristic symptoms (1). In field workshops held 1990-06-12 and 13 near Brandon and Winnipeg, respectively, personnel were shown how to diagnose FC and record survey data. To estimate efficiently the incidence of FC in the majority of fields where its incidence was likely to be very low, a novel surveying method was used. In a given field, a participant would record the length of time up to 5 min. until the first FC plant was observed in a walk from an arbitrarily selected starting point. If no FC plants were observed after 5 min., it was assumed that FC was absent; trials had shown that an average surveyor would see at least 10,000 plants in this time. Because FC frequently occurs in a patchy distribution, the number of FC plants among the total number of plants in the surrounding 1 square metre was then counted at the spot where the first FC plant was observed. In each surveyed field four such walks were conducted from 4 different, arbitrarily chosen, starting points. The observations were calibrated to a uniform standard for each surveyed field by estimating the distance walked in 20 sec. and the number of plants seen per metre walked. A typical entry on the survey form looked like this:

SURVEYOR: John PATTERSON
Address: Box 50, Hamiota, MB, R0M 0I0
tel/FAX: 764-2767/764-2759

DATE 90-07-09

LOCATION SE 30-14-21 RM Blanshard

FIELD (type) Virden barley (sample [90-07-09-01]; specimen log number)
Roblin wht -1, Canola -2 (crops in previous years)

	Walk 1	Walk 2	Walk 3	Walk 4
time to 1st FC	002 sec.	001 sec.	014 sec.	003 sec.
FC/plants in $1m^2$	12/216	20/268	12/260	12/228

(mean FC density of 4 'hot spots' = 6%)

distance/time (meters walked/20 sec.) = 15 m
plants/walked meter = 140.

Specimens of FC plants from each field where the disease was observed were forwarded promptly to the Plant Pathology Laboratory of Manitoba Agriculture to confirm the diagnosis (2). Surveyed fields with more than 5% FC plants in the 'hot spots' were defined as "fields with risk of loss due to FC", and fields with FC at lower levels as "fields with FC at subeconomic level". The locations of all surveyed fields were entered on a Manitoba grid map, the basis of the map shown in Fig. 1.

RESULTS AND COMMENTS The survey confirms the findings of earlier surveys (1,2) that FC is centred in western Manitoba in the area north of Brandon. The disease is now so well established in this area that virtually none of the surveyed fields were disease-free in the area roughly bounded by Brandon, Neepawa and Shoal Lake.

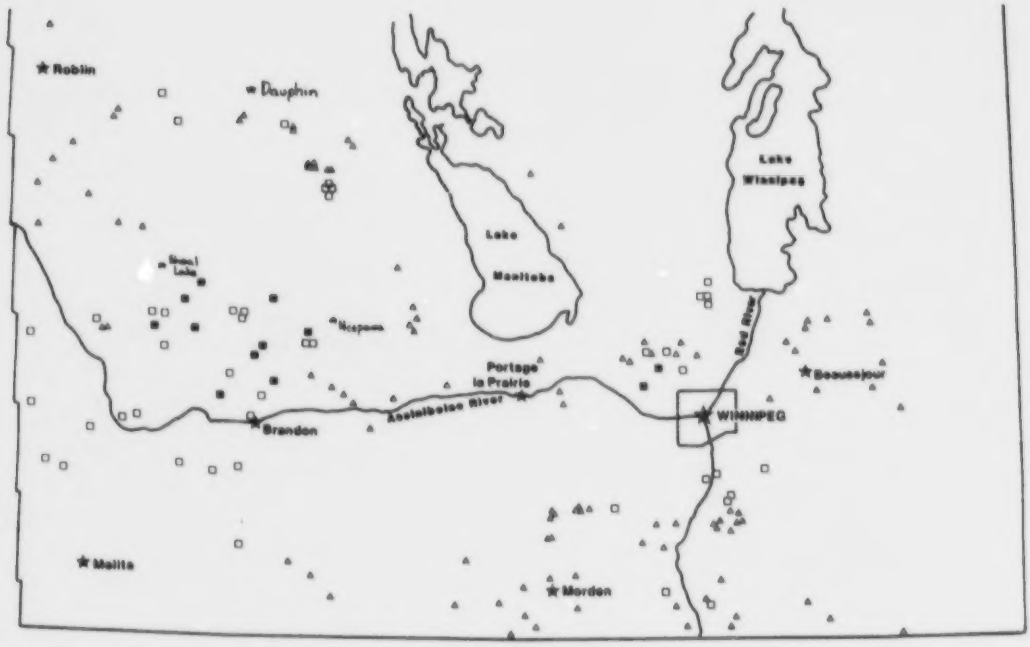

Figure 1. 1990 Manitoba flame chlorosis (FC) survey.
△ sites without FC; □ Sites with FC incidence below 5%; ■ sites with FC incidence above 5%.

This survey also records the first confirmed findings of FC in several new areas, such as the district of Dauphin and areas near the international border south of Brandon and in the southern Red River Valley. Since this is the first FC survey to examine these areas systematically, it is not certain whether these new findings of FC reflect recent spread to these areas or merely that a better search found FC that had been there for some time. Areas with a high proportion of FC sites (Brandon-Neepawa-Shoal Lake triangle, south Interlake) coincide with areas of highest combined frequency of cultivation of barley and wheat in Manitoba. This observation may be consistent with the trend observed elsewhere of increases in soil-borne virus diseases with increasingly intensive cultivation of small-grain cereal crops (1). In areas, such as southeastern Manitoba, where FC has been found at, generally, trace levels, and only since 1988 (1,2) future surveys should track changes in levels of disease intensity.

With several years of data from surveys similar to this one, it should be possible to establish the relationship between disease intensity and cereal cropping cycles, and to chart the future spread of this new disease.

REFERENCES

1) Haber, S., W. Kim, R. Gillespie and A. Tekauz 1990. Flame Chlorosis: a new soil-borne, virus-like disease of barley in Manitoba, Canada. J. Phytopathology 129(3):245-256.
2) Haber, S. 1990. Flame chlorosis: a new, virus-like disease of cereals in Manitoba: 1989 survey. Can. Pl. Dis. Surv. 70(1) p. 50.

Crop / Culture: Wheat, Barley

Location / Emplacement: Manitoba, Saskatchewan

Name and Agency / Nom et Organisation:
J.A. Kolmer and D.E. Harder
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Title / Titre: RUST DISEASES ON WHEAT AND BARLEY IN THE EASTERN PRAIRIES IN 1990

METHODS: Fields of cultivated wheat and barley were examined throughout the growing season in Manitoba and Eastern Saskatchewan for wheat leaf rust and stem rust on wheat and barley.

RESULTS AND COMMENTS: Leaf and stem rust of wheat were first observed June 21 in Winter wheat in southwestern Manitoba. By the first week in July, leaf rust was present in light to trace amounts in spring wheat fields throughout southern Manitoba. Leaf rust severities of 20-100% infection on suceptible cultivars were observed throughout southern Manitoba and eastern Saskatchewan (between Regina and Melfort) in the last week of July. Significant yield losses due to leaf rust were expected in winter wheats grown in Manitoba and Saskatchewan, as severities of 50-100% for both rusts were observed on winter wheat at Portage, Minto, Manitoba. The spring wheat and durum cultivars are all resistant to leaf and stem rust, and only trace to light levels of leaf rust were observed, and no stem rust at all was seen in these wheats.

Stem rust on barley was generally observed in trace to light amounts throughout southern Manitoba, and in pockets of southeastern Saskatchewan in the last week of July. However, stem rust severities were very high in fields of late planted barley in southern Manitoba, causing a large reduction in yield. None of the barley cultivars registered in western Canada have good resistance to the predominant races of stem rust.

Crop / Culture: Winter Wheat

Location / Emplacement: Region of St-Hyacinthe, Quebec

Name and Agency / Nom et Organisation:

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Service de la phytotechnie de
St-Hyacinthe, M.A.P.A.Q.
C.P. 480, St-Hyacinthe, Quebec J2S 7B8

Title / Titre: SURVEY OF WINTER WHEAT DISEASES IN 1990

METHODS: Nine fields: one of Augusta, two of Monopol, two of Perlo, and four of Karat were surveyed for leaf, root, and head diseases. Foliar diseases were assessed before and after heading on 10-20 plants at 10 sites on a W transect in the field examined. Samples of 10 plants were pulled out at each site to assess for root and basal stem diseases just after heading. Disease intensity of leaves were recorded as a percentage leaf area affected on the whole plant before heading, but on top leaves only after heading using the Horsfall and Barratt grading system[1]. Stem necrosis was assessed as the percentage of stems showing necrosis after removal of the leaf sheath of the basal portion. Head blight was measured as the percentage of heads and spikelets visually infected on 50 heads chosen at random at four different sites in the field.

RESULTS AND COMMENTS: Table 1 shows the minimum-maximum percentage disease intensity for the diseases recorded before and after heading. Before heading, tan spot (*Pyrenophora tritici-repentis*) was observed in all of the nine fields with a maximum of 7.8% of the leaves affected in the cultivar Karat. Powdery mildew (*Erysiphe graminis*) was low except in one field of the cultivar Monopol which had 12.3% infection before heading and 11.1% infection of flag leaves at ZGS 80. Leaf rust (*Puccinia recondita*) was observed only after heading on Monopol with 1.8% of flag leaves infected. Stem necrosis due mostly to *Bipolaris sorokiniana* and some *Fusarium* sp. was observed mostly as a slight necrosis in six of the fields with a maximum of 16.9% of the stems examined. Head blight (*Fusarium graminearum*) was most severe in the cultivar Augusta with a maximum of 2.8% infected spikelets (13.1%). However, all the fields were affected with a minimum of 0.1% infected spikelets. Take-all (*Gaeumannomyces graminis*) severely infected the cultivars Karat, Perlo, and Monopol with an estimated 40%, 30%, and 25% of plants affected respectively. The other fields showed only traces of infection.

Table 1. Prevalence and intensity of winter wheat diseases in the St-Hyacinthe region in 1990.

Growth stages[2]	% Minimum-Maximum Disease Intensity					
	Leaf spots	Powdery mildew	Leaf rust	Stem necrosis	Head blight heads	Head blight spikelets
Before heading*						
31	0-2.9	0-12.3	0	-	-	-
51	2.3-7.8	0-5.4	0	-	-	-
After heading**						
80	3.8-9.4	0-11.1	0-1.8	0-13.8	1.4-13.1	0.1-2.8

[1]Horsfall & Barratt grading system. 1945 Phytopathology 35(8): 655 (Abstr.).
[2]Zadoks *et al.* Growth stages of cereals. 1974. Weed Res. 14(6): 415-421.
*Disease assessment on all the leaves.
**Disease assessment on flag leaves only.

Forage legumes / Légumineuses fourragères

Crop / Culture: Alfalfa

Location / Emplacement: Nova Scotia

Title / Titre: A SURVEY TO DETERMINE THE DISTRIBUTION OF VERTICILLIUM WILT OF ALFALFA IN NOVA SCOTIA

Name and Agency / Nom et Organisation:

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Nova Scotia Agricultural College
P.O. Box 550, Truro, Nova Scotia B2N 5E3

METHODS: In 1989, 104 alfalfa fields from the major alfalfa producing counties in Nova Scotia were surveyed for verticillium wilt. Fields were visited once in July, August or September and a thorough search was made throughout the fields for wilt symptoms. Samples of plants showing symptoms were collected from each field and infection was confirmed by sporulation of the pathogen on ethanol medium.

RESULTS AND COMMENTS: Verticillium albo-atrum was found associated with wilt symptoms in alfalfa in 11 of the 104 fields surveyed. Distribution of infested fields is presented in Table 1.

Table 1. Distribution of Verticillium wilt in alfalfa in Nova Scotia.

Location	No. Infested Fields	No. Fields Surveyed
Cape Breton	3	10
Pictou County	0	11
Cumberland County	0	15
Truro and area	6	10
Annapolis Valley	1	27
Stewiacke and area	0	16
Antigonish County	1	15

Generally, verticillium wilt of alfalfa was concentrated in two centres: North Sydney in Cape Breton, and Truro in Colchester County. Symptoms were observed in fields sown as late as 1987. Infection appeared to be unrelated to host variety.

There is an indication that infested stands went undetected in this survey; a field in Pictou County that was infested in 1988 showed no symptoms in 1989. A similar phenomenon was observed in alfalfa surveys done in Prince Edward Island and New Brunswick in 1989. Perhaps the severe winter of 1988-89 resulted in the death of infected plants, leaving only healthy plants to survive.

ACKNOWLEDGEMENTS: This work was funded by the Canada/Nova Scotia Livestock Feed Development Agreement.

Crop / Culture: Alfalfa

Location / Emplacement: Nova Scotia

Name and Agency / Nom et Organisation:

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Title / Titre: A SURVEY TO IDENTIFY AND DETERMINE THE DISTRIBUTION OF VIRUSES IN ALFALFA IN NOVA SCOTIA

METHODS: In 1988, 82 alfalfa samples were collected from five locations in Nova Scotia: Cape Breton, Digby County, Kings County, Colchester County and Cumberland County. The mechanical sap inoculation technique was used to determine if viruses were present based on symptom expression on indicator plants. Indicator plants included: Vigna uniquiculata, Phaseolus vulgaris, Gomphrena globosa, Antirrhinum majus, Cucumis sativus, Medicago sativa, Pisum sativum, Spinacea oleracea, Trifolium pratense, and Trifolium repens. Samples were collected from May to August and frozen until late October when they were ground individually in 0.085% saline. Leaves of 10-day old indicator plants were dusted with diatomaceous earth, inoculated with alfalfa sap using a sterile cotton swab, and grown in a greenhouse for three weeks. Each inoculation was done separately to prevent cross-contamination.

RESULTS AND COMMENTS: Sap of 81 of the 82 alfalfa samples produced symptoms on the indicator plants suggesting that 98.8% of the samples were infected with a virus. Evidence from symptoms on indicator plants suggested that alfalfa mosaic virus (AMV), clover yellow mosaic virus and white clover mosaic virus were present. There was no evidence to suggest that red clover mottle virus, red clover vein mosaic virus, clover yellow vein virus, and red clover necrotic mosaic virus were present.

AMV is difficult to identify from indicator plants because it exists in a number of races. This study did not show clearly the incidence of this virus because symptom expression on indicator plants was inconsistent from sample to sample. Judging from symptoms produced on V. uniquicalata, however, AMV was present in 87% of the samples collected.

Most of the samples collected for this study were from symptomless plants. Apparently viruses, especially AMV, are present in almost all alfalfa in Nova Scotia. Spread within and between fields is probably aided by harvesting equipment. It is not known what effects latent viruses have on the longevity or yield of alfalfa in Nova Scotia, but if detrimental, this represents a serious problem.

Crop / Culture: Luzerne

Location / Emplacement: Ontario et Québec

Name and Agency / Nom et Organisation:

Y. Douville
35 Rivière-blanche
Saint-Thuribe, Québec

Title / Titre: GRAVITÉ DES MALADIES FOLIARES DE LA LUZERNE LE LONG DE LA 401 ET DE LA 138 EN ONTARIO ET AU QUEBÉC

METHODES: On a échantillonné des champs de luzerne de la région de Guelph jusqu'à la region de Trois-Rivières le 2 et le 3 octobre 1990. Dix plantes furent échantillonnées à dix pas de distance le long d'un parcours en triangle dans sept champs de luzerne en Ontario situés près de l'autoroute 401 et huit champs au Québec le long de la route 138. On a évalué le pourcentage de la surface foliaire couverte par les symptômes sur l'ensemble des feuilles en utilisant des figures de référence (1). Ce pourcentage fut établi sans etablir de distinction entre les maladies.

RESULTATS: En Ontario, le pourcentage de la surface foliaire couverte par les symptômes a varié entre 1 et 4%, avec une moyenne de 2,6%. Au Québec, ce pourcentage a varié entre 0.5 et 6% avec une moyenne de 3,1%. La maladie la plus fréquemment observée dans les deux provinces fut la tache commune.

1. Broscious, S.C., J.K. Pataky and H.W. Kirby. 1987. Quantitative relationships between yield and foliar diseases of alfalfa. Phytopathology 77:887-892.

Crop / Culture: Irrigated Alfalfa

Location / Emplacement: Saskatchewan

Title / Titre: VERTICILLIUM WILT AND FOLIAR DISEASES OF IRRIGATED ALFALFA IN SASKATCHEWAN IN 1990

Name and Agency / Nom et Organisation:

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REGINA, Saskatchewan S4S 0B1
Agriculture Canada Research Station
SASKATOON, Saskatchewan S7N 0X2

METHODS: Thirteen fields of irrigated alfalfa in southwestern Saskatchewan (Crop Districts 3 and 4) were surveyed on June 18 and 19, 1990 for symptoms of verticillium wilt (*Verticillium albo-atrum*). The survey concentrated primarily on areas with a history of verticillium wilt problems. All fields examined were produced for forage. Growth stage varied from late vegetative to early bloom. Samples of plants showing wilt symptoms were collected and taken to the laboratory for pathogen identification. Foliar diseases were identified based on visual symptoms.

RESULTS AND COMMENTS: Verticillium wilt was confirmed in two fields in the Miry Creek irrigation area near Cabri (Crop District 3). Verticillium had been found in this area during surveys conducted in 1983 and 1984, but not in 1987 to 1989. No verticillium wilt was found in the Chesterfield Flats irrigation area along the South Saskatchewan River near the Alberta border (Crop District 4). The disease had been found in this area each year from 1987-1989 but due to a coordinated clean-up effort, all affected fields had been rotated out of alfalfa for 1990.

The incidence and severity of foliar diseases was generally low. Spring black stem (*Phoma medicaginis* var. *medicaginis*) was present in most fields surveyed at trace to low levels. Trace levels of downy mildew (*Peronospora trifoliorum*) were found in eight fields.

Crop / Culture: Alfalfa

Location / Emplacement: Northeastern Alberta

Title / Titre: CROWN AND ROOT ROT OF ALFAFA SURVEY IN NORTHEASTERN ALBERTA 1990

Name and Agency / Nom et Organisation:

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B. Berg and B. Sharp
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Vermilion, Alberta T0B 4M0

METHODS: Twenty-eight alfalfa fields in northeastern Alberta were surveyed in 1990 for the incidence and severity of crown and root rot. Five plants were dug up at each of 10 sites, spaced equally along the arms of a W pattern. The plants were shaken free of soil, placed in a paper bag and stored in a cooler until processing. Plants were rinsed with tap water and split longitudinally to visually assess the severity of crown and root rot. Severity scores were assigned based on a scale of 0 to 3 where 0 = clean, 1 = 1-20%, 2 = 21-50%, and 3 = 51-100% of the crown and root discolored.

RESULTS AND COMMENTS: Crown and root rot occurred in all alfalfa fields surveyed, although considerable variation occurred in disease incidence and severity among locations (Table 1). The highest disease incidence occurred in fields near Lamont and the lowest incidence occurred near Lloydminster. The mean disease incidence for all fields was 74.9% and the mean disease severity was 1.26.

Table 1. Incidence and severity of crown and root rot of alfalfa in northeastern Alberta in 1990.

Location	No. of fields surveyed	Incidence %		Severity	
		Mean	Range	Mean	Range
Lamont	4	90.0	68-100	1.83	1.3-2.1
Lloydminster	4	58.8	36-80	0.93	0.4-1.5
Ryley	4	76.3	64-97	1.25	0.9-2.2
St. Paul	4	66.5	52-84	0.88	0.6-1.2
Smoky Lake	4	68.8	40-96	1.00	0.4-1.8
Vegreville	4	84.3	73-96	1.48	1.0-1.8
Vermilion	4	79.3	42-100	1.43	0.5-2.1
Total/Average	28	74.9	--	1.26	--

Crop / Culture: Forage Grasses

Name and Agency / Nom et Organisation:

B.D. Gossen and D. Regnier, Agriculture Canada Research Station, 107 Science Crescent, Saskatoon, Saskatchewan S7N 0X2

Location / Emplacement: Saskatchewan and Alberta

Title / Titre: HEAD AND STEM SMUT OF GRASSES IN 1990.

METHODS: One hundred and sixty-nine sites in Saskatchewan and eight sites in southern Alberta were examined between June 18 and July 19, 1990, for the presence of head smut (Ustilago bullata) and stem smut (U. hypodytes) of grasses. This included almost all of the meadow bromegrass (Bromus riparius) fields grown for certified seed production and seed fields of numerous other grasses, but most of the sites were ditches, pastures and potholes, where a number of grass species were found. At each site, the dominant grass species was identified. Where these diseases occurred, the percentage of infected plants of each species was assessed. A teardrop pattern was used for sampling, and identification of pathogens was based on symptoms. Samples of smutted heads were collected and the identity of U. bullata in several samples was confirmed by examination of spore morphology and germination.

RESULTS AND COMMENTS: The results are summarized in Table 1 and Figure 1. Head smut was found in six of the 10 seed fields of meadow bromegrass which were examined, but disease incidence was generally less than 1%. The pathogen was not found in two stands where it was observed in 1989. In northern and central areas, the pathogen was found at trace levels in many stands of foxtail barley (Hordeum jubatum). In southern areas, stands of foxtail barley were occasionally heavily infected (up to 40% infection, with localized areas over 80%). Downy brome (B. tectorum) was found at only two sites and plants infected with U. bullata (5% and 1%) were observed at both locations. Infection of slender wheatgrass (Elymus trachycaulus) and quackgrass (Agropyron repens) was noted infrequently and generally at trace levels.

The high incidence and severity of head smut in southern Alberta may be an artifact of sampling rather than a reflection of the importance of the pathogen in this region. Six of the eight grass stands examined were meadow bromegrass and foxtail barley, which are both hosts of the pathogen. Seed fields of meadow bromegrass in central Alberta and in British Columbia were also infested with the pathogen (G. Jesperson and D. Orr, personal communication). The pathogen was not found on crested wheatgrass (A. cristatum) or smooth bromegrass (B. inermis), two grass species which are widely grown throughout the survey area.

Stem smut was commonly observed on crested wheatgrass throughout southern Saskatchewan. Its distribution was highly variable. In several instances, the pathogen was found at moderate to high levels (>10%) on one side of a road, and only at trace levels on the other side. Infection of 5-10% of the plants was common. Infection levels were generally lower in pastures than in ditches and waste areas. Stem smut was occasionally observed on slender wheatgrass and quackgrass and was noted very infrequently, and only at trace levels, on western wheatgrass (A. smithii).

Table 1. The occurrence and severity of head and stem smut of grasses in Saskatchewan (by Crop District) and southern Alberta in 1990.

Location	Number of sites	Head smut		Stem smut	
		Incidence	%Plants	Incidence	%Plants
Saskatchewan					
CD 2 (south-east)	10	0	-	30%	1-25%
CD 3 (south-central)	26	0	-	46%	1-50%
CD 4 (south-west)	25	16%	1%	24%	1-80%
CD 6 (central)	49	4%	1%	33%	1-15%
CD 7 (west-central)	16	0	-	38%	1-40%
CD 8 (north-west)	19	21%	1-40%	5%	Trace
CD 9 (north-west)	24	13%	1-40%	0	-
Southern Alberta	8	75%	1-40%	0	-

Acknowledgment: Many thanks to G.D. Jesperson, S. Evans, W.W. Reiter, S.M. Gossen and K. Montgomery who assisted in this survey. This study was funded in part by the Agriculture Development Fund of Saskatchewan and the Canadian Seed Growers Association.

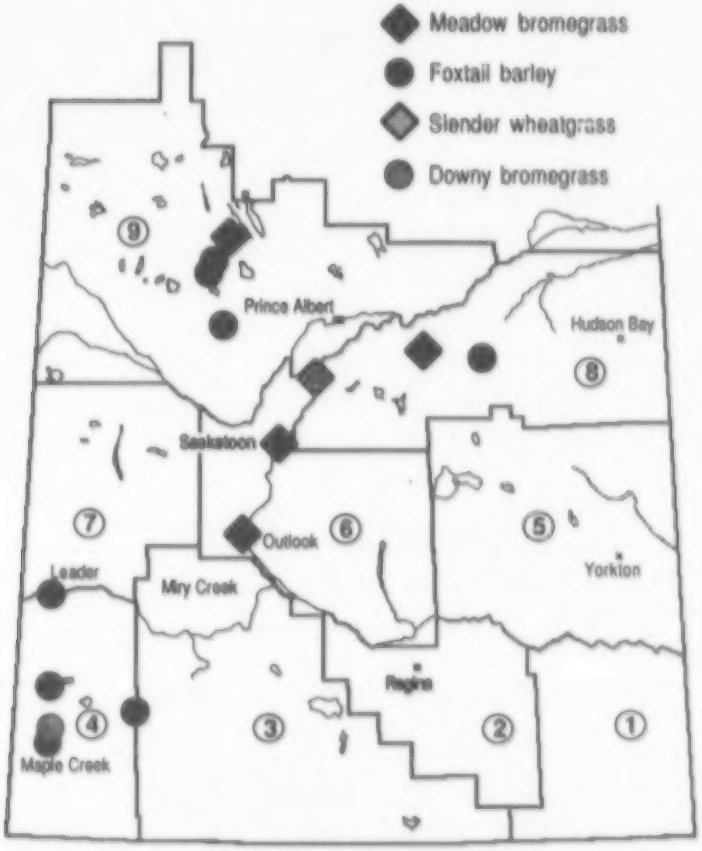


Figure 1. Locations in Saskatchewan where head smut (Ustilago bullata) was observed in 1990.

Crop / Culture: Forage Grasses

Location / Emplacement: Southern Alberta

Name and Agency / Nom et Organisation:

R.J. Howard and E.R. Moskaluk
Alberta Special Crops and Horticultural Center, Bag 200, Brooks, Alberta T0J 0J0

Title / Titre: SURVEY FOR DISEASES OF FORAGE GRASS SEED CROPS

METHODS: Twenty-three forage grass seed fields in southern Alberta (Fig. 1) were surveyed for diseases between June 26 and July 18, 1990. The survey procedure consisted of walking through each field in a teardrop pattern, stopping every 200 paces to dig up a clump of grass for a total of 10 stops per field. The samples were bagged and returned to the laboratory where disease observations were made on the roots, crowns and foliage. Subsamples of diseased tissue were assayed for fungal pathogens by surface sterilizing in 1% sodium hypochlorite for one minute, rinsing in sterile water, and plating onto assorted agar media. Plates were incubated at 20-24°C for 5-7 days before observation. Prevalent fungal species were subcultured and retained for pathogenicity tests, which are pending. Information on the cultural practices for each crop was obtained from the individual producers.

RESULTS AND COMMENTS: Thirteen kinds of forage grasses were surveyed (Table 1). Nine of the fields were irrigated and 14 were under dryland production. The main diseases observed and their suspected causes were:

1. Crown and root rot (CR): *Fusarium* spp.
2. Leaf and stem spots (LS): *Alternaria*, *Drechslera*, and *Fusarium* species.
3. Nodal discoloration (ND): *Fusarium* spp. and insect damage.
4. Powdery mildew (PM): *Erysiphe graminis*.
5. Scorched leaf tips (SC): Physiological, probably drought stress and/or salinity.
6. Head smut (SM): *Ustilago bullata*.
7. White (sterile) heads (WH): *Fusarium* spp. and insect damage. This disorder was often seen in conjunction with nodal discoloration.

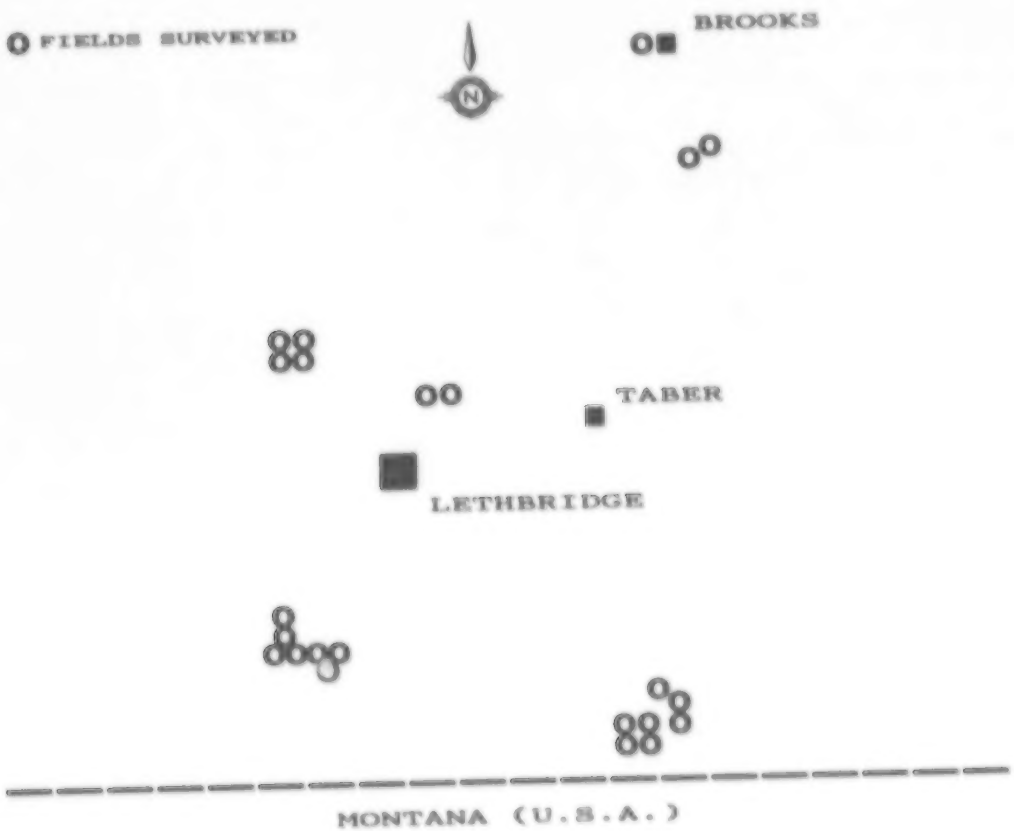
Physiological leaf scorch was the most prevalent disease. It was seen on all but western wheat grass. Scattered dark brown spots were observed on the leaves and stems of most kinds of grasses. Although various species of fungi were isolated from these spots, their pathogenicity remains to be determined. The overall severity of these leaf and stem spot diseases was rated as slight. Root and crown rots were also minor in incidence and severity. Nodal discoloration, a disorder that was often associated with sterile heads ("whiteheads"), was observed on kentucky blue, meadow brome and northern wheat grasses. Insect-feeding damage, presumably caused by grass-feeding plant bugs, was sometimes observed at or near the affected nodes. *Fusarium* spp. were frequently isolated from the nodes and from the shrivelled, discolored ends of the seed stalks at a point on the stem just above the node. Head smut was the most serious infectious disease. It occurred on ca. 10% of the heads in a stand of 'Regar' meadow brome and on up to 50% of the heads in one field of slender wheat grass.

Table 1. Results from a disease survey of 23 forage grass seed fields in southern Alberta in 1990.

Grass	No. fields surveyed	Production[1] system	Disease[2] symptoms
Altai wild rye	2	D	CR, LS, SC
Crested wheat	5	D	CR, LS, ND, SC, SM
Kentucky blue	1	I	LS, PM, SC, WH
Meadow brome	2	I	LS, ND, SC, SM, WH
Northern wheat	1	I	CR, LS, ND, SC, WH
Orchard	2	I	LS, SC
Perennial rye	1	I	LS, SC
Pubescent wheat	2	D	CR, SC
Russian wild rye	1	D	LS, SC
Slender wheat	1	D	LS, SC, SM
Smooth brome	3	D	CR, LS, ND, SC
Tall fescue	1	I	LS, SC
Western wheat	1	I	LS
	23		

[1] Production system: D = Dryland, I = Irrigated.
[2] Disease symptoms: CR = crown and/or root rot, LS = leaf and/or stem spots, ND = node discoloration, PM = powdery mildew, SC = scorched leaf tips, SM = smutted heads, and WH = white (sterile) heads.

Figure 1. Locations of forage grass seed fields surveyed for diseases in southern Alberta in 1990.



Oilseeds and special crops / Oléagineux et cultures spéciales

Crop / Culture: Canola

Location / Emplacement: Manitoba

Title / Titre: Distribution, Prevalence and Incidence of Canola Diseases in 1990

Name and Agency / Nom et Organisation:

Van Den Berg, C. G. J.
Department of Plant Science
University of Manitoba
Winnipeg, Manitoba and
Platford, R. G.
Manitoba Agriculture
Agricultural Services Complex
Winnipeg, Manitoba

Methods: Two surveys were conducted in southern Manitoba. During the first, 45 fields of Brassica napus were surveyed in the southern crop districts in the second week of August. During the second, 33 fields of B. napus and 5 fields of B. rapa (B. campestris) were surveyed in the northern crop districts in the third week of August. The presence of various diseases was noted in each field. For each field, disease incidence was determined on a sample of 50 - 60 plants. In addition, results are included from one sample that was received by the plant pathology laboratory of Manitoba Agriculture.

Results and Comments: Blackleg, caused by Leptosphaeria maculans, was found in 41 of 84 fields (Table 1; Figure 1). Fields with blackleg were found in most crop districts. Mean incidence was low (≤ 10%) in fields of eastern crop districts and very high (≥ 70%) in fields of western crop districts. Observed symptoms included the typical stem canker, grey discoloration of the stem and elongated lesions on various parts of the stem. Disease severity on the affected plants was very variable. In some fields, infected plants did mature somewhat earlier, but still gave a fair seed yield.

Sclerotinia stem rot, caused by Sclerotinia sclerotiorum, was observed in 32 fields (Table 1; Figure 1). Affected fields were found in most crop districts. Disease incidence was less than 5% in most fields, but reached 10% in some.

Footrot, caused by Fusarium spp. and Rhizoctonia solani, was observed in 21 fields distributed throughout Manitoba (Table 1). Prevalence was higher in crop districts 4, 5 and 6 than in other districts. In most fields incidence was less than 10%, however; it reached 24% in one field in district 4. A trace of aster yellows was observed in seven fields, distributed among several crop districts.

Staghead, caused by Albugo candida was observed in two fields in crop district 4. Incidence was 4% in both fields. Blackspot, caused by Alternaria spp., was observed in one field in crop district 4. Aphids were present in many fields throughout Manitoba. Severe infestations were observed in districts 7, 8, 9 and 11.

In summary, footrot, blackspot, staghead and aster yellows were present at low levels in 1990. The yield loss caused by these diseases will be negligible. Aphids were present in large numbers. The effect of aphids on seed yield is unknown, but the observed infestations suggest that they may have had an effect. Sclerotinia was generally present in low levels. The yield loss caused by sclerotinia will be small. Blackleg was observed in many fields and often at very high levels. Based on the seed yield of infected plants, yield losses up to 50% may be attributed to blackleg in individual fields in 1990.

Table 1. Prevalence and incidence of canola diseases by crop district in Manitoba in 1990.

Crop District	No. of sampled fields	Number of affected fields				Range of Incidence%	
		Blackleg	Sclerotinia	Foot rot	Aster Yellows	Blackleg	Sclerotinia
1	5	5	-	1	-	18-98	-
2	6	6	-	-	-	12-66	-
3	4	2	2	1	-	18-68	2-4
4	11	7	6	7	1	2-76	2-6
5	13	2	9	4	-	2-10	2-10
6	14	8	10	6	2	4-94	2-12
7	12	4	1	1	1	2-70	5
8	8	4	-	-	-	2-38	-
9	7	3	3	1	1	2-10	3-8
11	4	-	1	-	-	-	5
total	84	41	32	21	7		

DISTRIBUTION OF FIELDS INCLUDED IN MANITOBA CANOLA SURVEY (1990)

Crop / Culture: Canola

Location / Emplacement: Saskatchewan

Title / Titre: CANOLA DISEASES IN N.E. SASKATCHEWAN, 1990

Name and Agency / Nom et Organisation:

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METHODS: Seventy-five canola fields were surveyed between July 31 and August 14, 1990 in Saskatchewan Agriculture Crop Districts 5b, 8a, 8b and 9a. Fields were sampled by collecting one plant at ten sites located on a diagonal transect. Diseases were identified by symptoms, and the severity of each disease recorded as an estimated percentage area affected of the leaf or stem. Root rot and blackleg were assessed on a scale of 0=healthy, 2=trace, 5=moderate and 10=severe. Results were averaged over the total number of samples and fields, and the disease index, an estimate of severity, was calculated for each disease. The percentage of fields affected was calculated for an estimate of prevalence.

RESULTS AND COMMENTS: Black spot (*Alternaria* spp.) was the most severe disease this year (Table 1), followed by blackleg (*Leptosphaeria maculans*). White rust of leaves and staghead of flowering shoots (*Albugo candida*) were less severe than the average for the last three years. Downy mildew (*Peronospora parasitica*) was present for the first time in two years, but not as severe as in 1987. Root rot (*Rhizoctonia solani* & *Fusarium* spp.) was present at low levels. In addition to the diseases in the table, stem rot (*Sclerotinia sclerotiorum*) and aster yellows (mycoplasma) were found at very low levels in crop district 9a.

Table 1. Severity and prevalence of canola diseases in 1990

Crop District	No. Fields	Disease index/% fields affected					
		Black spot	Black-leg	White rust	Stag-head	Downy mildew	Root rot
5b	13	1.0/92	0.6/38	0.2/23	0.1/15	0/0	0/0
8a	21	2.2/100	0.9/52	0.5/48	<0.1/5	<0.1/5	<0.1/5
8b	21	1.3/86	0.8/71	0.1/14	0.1/5	0/0	0/0
9a	20	3.4/100	0.6/55	0.3/25	0.3/15	<0.1/5	<0.1/5
Total or average	75	2.1/95	0.7/56	0.3/28	0.1/9	<0.1/3	<0.1/3

Crop / Culture: Canola

Location / Emplacement: Saskatchewan

Name and Agency / Nom et Organisation:

T.K. Turkington and R.A.A. Morrall
Department of Biology
University of Saskatchewan, Saskatoon
Saskatchewan, S7N 0W0

Title / Titre:

Surveys of sclerotinia stem rot of canola in Saskatchewan, 1985 to 1990.

METHODS: Canola crops were surveyed for sclerotinia stem rot (Sclerotinia sclerotiorum) from 1985-90 in several areas (1) of Saskatchewan. Disease incidence was assessed at Meadow Lake, Melfort, Outlook, and Shellbrook; however, not all areas were sampled in each year. Crops were visited in August shortly before swathing and disease incidence assessed by counting the number of infected plants out of a random sample of 200 plants at each of 4-5 sites. The sampling sites were randomly located in each field and were at least 10 m from the edge and spaced >50 m apart. Mean disease incidence (MDI) (%) was then calculated for each crop.

RESULTS AND COMMENTS: Overall mean disease incidence and the number of crops in three incidence categories (MDI = 0, MDI > 0 but < 20, and MDI ≥ 20) are reported for each year and location in Table 1. Mean disease incidence was highest at Meadow Lake in 1986 (19.7%) and 1989 (20.7%), and lowest at Outlook in 1988 (1.4%). The majority of crops had some sclerotinia, but very few had MDI over 20%. The exception was at Meadow Lake in 1986 and 1989 where a substantial number of crops had MDI ≥ 20%. Differences among years may have reflected moisture conditions. In general fungicide application to control sclerotinia stem rot would have been economical in approximately 11% of the crops from 1985-90.

REFERENCES:

1. Jesperson, G.D. 1990. Survey of blackleg and sclerotinia in Saskatchewan canola crops, 1989. Can. Plant Dis. Surv. 70: 69-70.

Table 1. Sclerotinia survey data for various areas of Saskatchewan, 1985-90.

Year, area & crop district	Sample size	Overall mean disease incidence (%)	Number of crops with mean disease incidence (MDI) (%) of		
			MDI = 0	MDI > 0 but < 20	MDI ≥ 20
1985					
Melfort 8	201	8.8	6	176	19
1986					
Meadow Lake 9B	37	19.7	0	21	16
Melfort 8	78	4.9	15	58	5
Shellbrook 9A	14	8.0	0	12	2
1987					
Melfort 8	61	2.5	15	44	2
1988					
Meadow Lake 9B	42	8.8	0	36	6
Outlook 6B	23	1.4	9	14	0
1989					
Meadow Lake 9B	18	20.7	0	10	8
1990					
Meadow Lake 9B	36	3.0	5	31	0

Crop / Culture: Canola

Name and Agency / Nom et Organisation: K.L. Conn and J.P. Tewari
Department of Plant Science
University of Alberta
Edmonton, Alberta
T6G 2P5

Location / Emplacement: Central Alberta

Title / Titre: SURVEY OF ALTERNARIA BLACKSPOT AND SCLEROTINIA STEM ROT OF CANOLA IN CENTRAL ALBERTA IN 1990

METHODS: Sixty-three randomly selected fields of canola were surveyed in central Alberta during the third week of August, 1990. Fifty-nine of these fields were of Brassica campestris and 4 were of B. napus. The disease severity at 2 locations within each field, away from the edge or corners, was estimated visually and the average recorded. For assessment of alternaria blackspot caused by Alternaria brassicae, percent areas of siliqua covered with lesions were determined using an assessment key (Conn et al., 1990). Fields with less than 1% alternaria blackspot were categorized as having trace levels. For assessment of sclerotinia stem rot caused by Sclerotinia sclerotiorum, the percentage of stems with symptoms was determined. Fields with between 0 and 1% sclerotinia stem rot were categorized as having trace levels.

RESULTS AND COMMENTS: Every field surveyed had alternaria blackspot. Percent areas of siliqua covered with lesions ranged from trace levels to 20% (Fig. 1). If the fields with trace levels are set to 0%, then the mean percent area of siliqua covered with lesions for the 63 fields was 2%. In the survey of 57 fields in 1989 the mean was 20% (Conn and Tewari, 1990). This difference was probably due to weather. In 1989 the latter part of July and early part of August were wet, whereas in 1990 it was hot and dry during this period in most areas. The percentage of stems with sclerotinia stem rot ranged from 0 to 70% (Fig. 2). If the fields with trace levels are set to 0%, then the mean percent sclerotinia stem rot for the 63 fields was 10%. In the survey of 57 fields in 1989 the average was 12% (Conn and Tewari, 1990). The average percentage of sclerotinia stem rot was not affected much by the weather in early August, but the extent of infection on plants was. During 1989 infection was present both on the lower and upper parts of stems. In 1990 infection was largely confined to the lower parts of stems.

During this survey the presence or absence of some other diseases was also noted. Staghead caused by Albugo candida and aster yellows caused by MLO were observed in the majority of fields surveyed. In 1989 these diseases were found in 2 fields only (Conn and Tewari, 1990). Some fields had as many as 3 stagheads per square meter. Gray stem caused by Pseudocercosporella capsellae was present in many fields again this year.

ACKNOWLEDGEMENT: This survey was financed by grants from the International Development Research Centre, Ottawa and the Natural Sciences and Engineering Research Council of Canada, Ottawa.

REFERENCES: Conn, K.L., Tewari, J.P. and R.P. Awasthi. 1990. A disease assessment key for alternaria blackspot in rapeseed and mustard. Can. Plant Dis. Surv. 70(1):19-22.

Conn, K.L. and J.P. Tewari. 1990. Survey of alternaria blackspot and sclerotinia stem rot in central Alberta in 1989. Can. Plant Dis. Surv. 70(1):66-67.

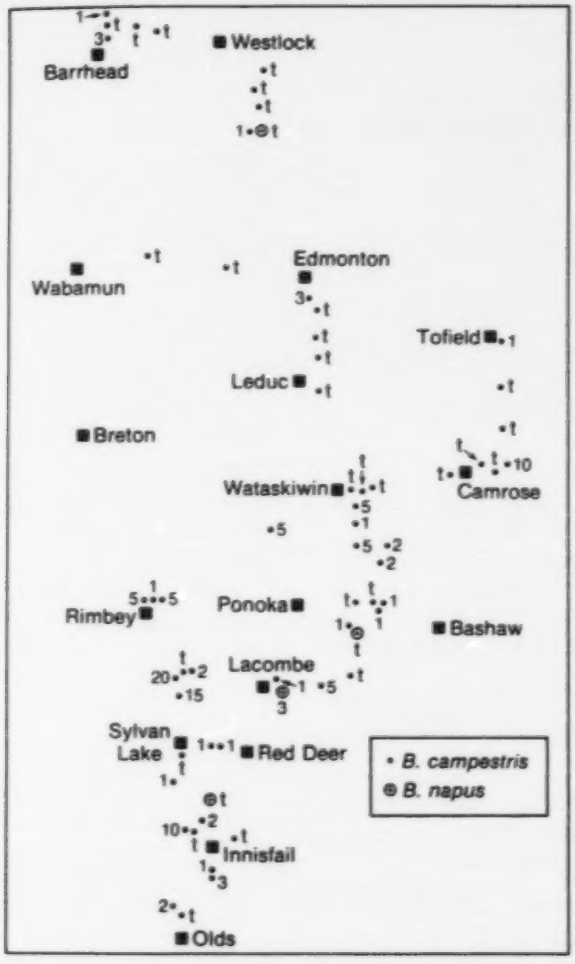

Figure 1. Locations of fields in central Alberta surveyed for alternaria blackspot in 1990. The numbers represent percent areas of siliqua covered with lesions. Fields with less than 1% infection were categorized as having trace (t) levels.

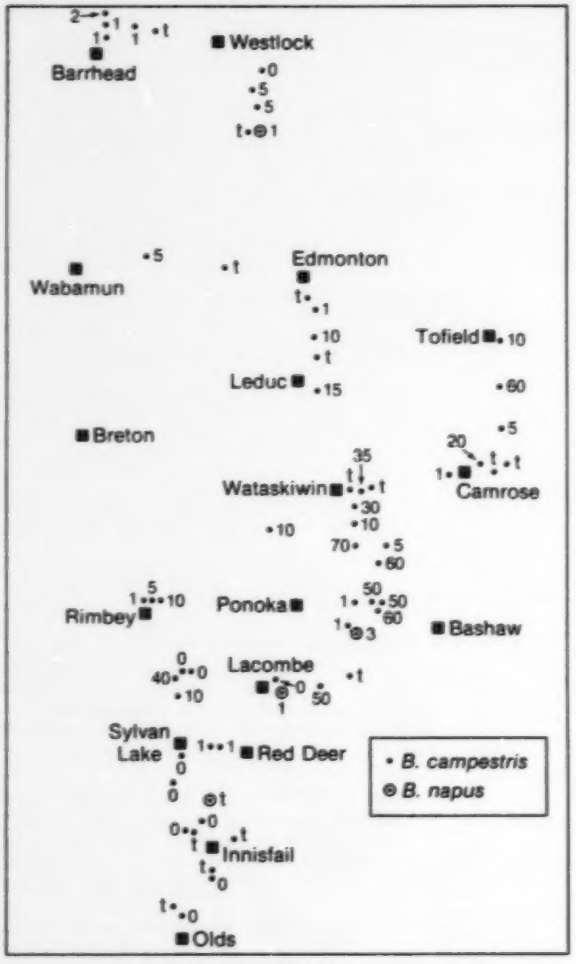

Figure 2. Locations of fields in central Alberta surveyed for sclerotinia stem rot in 1990. The numbers represent percent of stems with symptoms. Fields with between 0 and 1% infection were categorized as having trace (t) levels.

Crop / Culture:
Canola

Location / Emplacement:
Alberta

Title / Titre:

BLACKLEG OF CANOLA SURVEY
IN ALBERTA - 1990

Name and Agency / Nom et Organisation:

EVANS, I.R., Plant Industry Division, Alberta Agriculture, Edmonton, Alberta
KHARBANDA, P.D., Alberta Environmental Centre, Vegreville, Alberta;
HARRISON, L., Regional Crop Laboratory, Alberta Agriculture, Fairview, Alberta;
KAMINSKI, D., Alberta Special Crops and Horticultural Research Center, Brooks, Alberta.

INTRODUCTION AND METHODS:

A third annual province-wide survey for virulent blackleg of canola (Leptosphaeria maculans) was carried out in July and August. The survey was done by provincial/municipal fieldmen and Agriculture Canada seed inspectors with diagnostic assistance from plant pathologists at Brooks, Fairview, and Vegreville.

This year's survey was again based on inspecting a minimum of one commercial field for every 2,000 ha of canola in Alberta. Co-operators were asked to survey fields where producers grew canola on canola or followed very short rotations. Number of fields surveyed was determined by the acreage of canola grown in each of the 67 municipalities and districts. Each field was sampled as previously described (1).

RESULTS AND COMMENTS:

The results are summarized in Table 1. Infested fields continue to be concentrated in east-central Alberta, census divisions 7 and 10 (2). There are still municipalities in and around this region in which no virulent blackleg has been found. Provincewide blackleg was present in 3 out of 595 pedigreed seed fields surveyed. The infested seed fields were found in census division 10.

Spring weather conditions were conducive to blackleg infection and development. Levels of disease, however, were lower in 1990 than 1989, although the disease was found in new locations that included the Counties of Thorhild and Wetaskiwin. The lower disease incidence was likely due to most farmers following a 4-year crop rotation recommended for canola. In total, including seed fields, 1579 canola fields were surveyed this year. Southern and western Alberta are relatively free of virulent blackleg and to date none has been found in the Peace Region.

In the east central region 85 out of 293 canola fields had trace to 5% levels of blackleg. On a provincewide basis this translates into 85 out of 984 commercial fields, giving an average of just under 10%. Overall yield losses from virulent blackleg in Alberta would not be expected to exceed 1% of actual canola yields.

TABLE BLACKLEG OF CANOLA SURVEY IN ALBERTA - 1990

Municipalities with Confirmed Virulent Blackleg of Canola

MUNICIPALITY	NUMBER OF FIELDS SURVEYED	NUMBER OF FIELDS WITH VIRULENT BLACKLEG
EAST CENTRAL ALBERTA		
Co. of Thorhild #7	14	2
Co. of Paintearth #18	16	7
Co. of Flagstaff #29	101	23
Co. of Beaver #9	25	7
Co. of Smoky Lake #13	8	1
Co. of Vermilion River #24	31	9
Co. of Minburn #27	36	11
M.D. of Provost #52	40	22
M.D. of Wainwright #61	17	2
M.D. of Wetaskiwin #10	5	1
TOTAL	293	85

REFERENCES:

1. Evans, I.R., P. Kharbanda, L. Harrison, D. Kaminski, 1990. Blackleg of canola survey in Alberta - 1989. Can. Plant Dis. Surv. 70(1):63-64.

2. Kharbanda, P.D., I.R. Evans, L. Harrison, S. Slopek, H.C Huang, D. Kaminksi, and J.P. Tewari, 1989. Blackleg of canola survey in Alberta - 1988. Can. Plant Dis. Surv. 69(1):55-57.

3. McGee, D.C. and G.A. Petrie. 1978. Variability of Leptosphaeria maculans in relation to blackleg of oilseed rape. Phytopathology 68:625-630.

Crop / Culture: Rapeseed/Canola

Location / Emplacement: Alberta

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Title / Titre: CANOLA DISEASE SURVEY IN THE PEACE RIVER REGION IN 1990

METHODS: A survey of 78 rapeseed/canola fields was conducted in July and August, 1990 in the Peace River region of Alberta. The total area of canola production in 1990 was approximately 700,000 acres (283,000 hectares). The diseases reported in this survey were the same as in 1988 and 1989 and include root rot, foot rot, sclerotinia stem rot, black spot and blackleg.

Fields were sampled by walking into each one in a W pattern and collecting the first plants at a site 100 paces from the edge of the field. Ten plants were selected at random at each of five sites along the W pattern for a total of 50 plants per field. Disease incidence was recorded on every plant. Root rot ratings were recorded using a 0-4 scale, where 0 = no lesions on taproot, 1 = light brown lesions on taproot but no girdling, 2 = coalesced brown lesions on taproot but no girdling, 3 = dark brown lesions girdling taproot above main laterals (wirestem appearance), 4 = severe necrotic lesions on taproot, roots rotted off and plant dead.

RESULTS AND COMMENTS: The results are given in Table 1. The root rot complex was, as in previous years, the most prevalent disease, affecting 100% of the fields surveyed with a mean of 96.4% of the plants infected (Table 1). Disease incidence was higher than in 1989 when a mean of 47.6% of plants were infected. In 1990 disease severity was higher than in 1989 but slightly lower than in 1988. Mean root rot ratings in 1988, 1989 and 1990 were 2.4, 1.1 and 2.2, respectively. Prevalence of Sclerotinia stem rot decreased in 1990, due to extremely dry weather after flowering, with 41% of fields infested compared to 48% in 1989. The incidence of stem rot decreased with a mean of 9.6% of plants infected per field. Prevalence of black spot, foot rot and avirulent blackleg increased in 1990 with 95%, 92% and 52% respectively. No virulent blackleg was found. Other diseases observed were greystem, white rust (staghead), sulphur deficiency, herbicide damage, pod drop from drought stress and sooty mold. Insect damage from maggots, lygus bugs, bertha army worms, diamond back moth larvae, and cut worms was also observed.

Table 1. Prevalence and incidence of root rot, foot rot, sclerotinia stem rot, blackleg and black spot of canola in the Peace River region in 1990.

Disease	Prevalence (% fields infested)	Incidence (% plants infected)
Root Rot (*Rhizoctonia*, *Pythium*, *Fusarium*)	100	96.4
Black Spot (*Alternaria* spp.)	95	32.3
Foot Rot (*Rhizoctonia*, *Fusarium*)	92	34.0
Stem Rot (*Sclerotinia sclerotiorum*)	41	9.6
Avirulent Blackleg (*Leptosphaeria maculans*)	38	4.3

Crop / Culture: Canola

Location / Emplacement: Alberta

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Title / Titre: SURVEY OF SCLEROTINIA STEM ROT IN SOUTH-CENTRAL ALBERTA, 1990

METHODS: Thirty-five randomly selected swathed canola fields were surveyed for stem rot (*Sclerotinia sclerotiorum*) from September 18 to 20. Fields were surveyed by walking 50 paces into the field and then proceeding along an inverted "V" sampling pattern. One hundred canola stems (stubble) were examined at each of 5 locations along the sampling pattern at 25 pace intervals. The number of stems with discrete stem rot lesions and/or bleached stems resulting from stem rot infection were recorded.

RESULTS AND CONCLUSIONS: Stem rot was found in all of the fields surveyed. The percentage of infected stems per field ranged from 0.2 to 46.0 with a mean of 8.8 per field. The field with 46.0 percent infected stems was very weedy, in particular, with Canada thistles. This may have been a factor in the build-up of stem rot in this field. Using the yield loss formula developed by Morrall, Dueck & Verma (1984) that states percent yield loss due to stem rot is generally 0.4 to 0.5 x percent infected plants, it is estimated that stem rot resulted in at least 3.5 to 4.4 percent yield loss in south-central Alberta. Actual yield losses may have been higher; the percentage of infected plants was probably underestimated since only the lowest part of the stem (stubble) could be assessed for stem rot infection. Precipitation in the survey area for the period of May 1 to July 31 was above normal in 1990 in the Red Deer (174 percent of 1951 - 1980 average precipitation) to Calgary (125 percent) region. Stem rot levels may therefore have been higher in 1990 than in most years in this area.

REFERENCES: Morrall,R.A.A., J.Dueck, and P.R.Verma. 1984. Yield losses due to sclerotinia stem rot in western Canadian rapeseed. Can.J.Plant Path. 6:265 (Abstr).

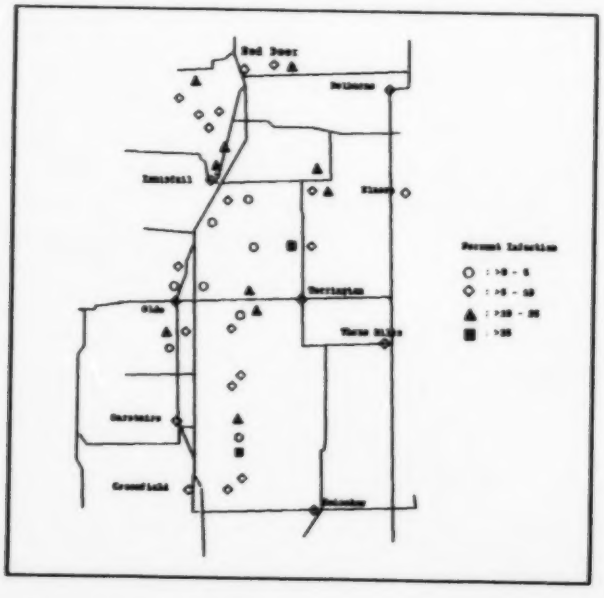

Figure 1. Locations of fields surveyed for stem rot in 1990.

Crop / Culture: Flax

Location / Emplacement: Manitoba

Title / Titre: SURVEY OF FLAX DISEASES IN MANITOBA IN 1990

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Methods: A total of 33 flax fields were surveyed in southern Manitoba in 1990. Nineteen fields were surveyed on July 25, six on August 2 and eight on August 21. Fields were selected at random in different regions. Each field was sampled by two persons walking 100 m in opposite directions inside the field following an inverted V pattern. Diseases were identified by symptoms and the incidence and severity of each disease were recorded. In addition, 25 samples of flax were submitted for analysis to the Manitoba Agriculture Plant Pathology Laboratory by agricultural representatives and growers.

Results: Crop emergence was good and the stand was good to excellent in most of the fields surveyed. The soil moisture was relatively adequate and the crop vigour was generally good to fair in most fields. The incidence of heat canker was very low in the spring. Fusarium wilt (*Fusarium oxysporum* f. sp. *lini*) was observed in two fields; 5% infected plants in one field and less than 1% in the other. Pasmo (*Septoria linicola*) and leaf spotting (*Alternaria linicola*) each occurred at less than 1% severity in single fields. Rust (*Melampsora lini*) was not observed in any of the 33 fields surveyed nor on the 30 rust differential lines planted at Morden and Portage la Prairie. Aster yellows (Mycoplasma like organism) was not encountered in this survey. Chlorosis, a nutritional disorder, was observed in three fields in southeast Manitoba with a severity range of 5% to 50% chlorotic plants.

Of the 25 samples submitted to the Manitoba Agriculture Plant Pathology Laboratory, 3 showed seedling blight (*Rhizoctonia solani*, *Fusarium* spp.), 9 root rot (*Fusarium* spp. including 3 with *Fusarium equiseti* and 2 with *Fusarium acuminatum*), 1 fusarium wilt (*Fusarium oxysporum* f. sp. *lini*), 8 environmental stress and 4 herbicide injury.

Crop / Culture: Flax

Location / Emplacement: Saskatchewan

Title / Titre: FLAX DISEASES IN N.E. SASKATCHEWAN, 1990

Name and Agency / Nom et Organisation:

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METHODS: Thirty-five flax fields were surveyed between July 31 and August 14, 1990 in Saskatchewan Agriculture Crop Districts 5b, 8a, 8b and 9a. Fields were sampled by collecting one plant at ten sites located on a diagonal transect. Diseases were identified by symptoms, and the severity of each disease recorded as the estimated percentage area affected of the leaf, stem or root. Results were averaged over the number of samples and fields, and the disease index, an estimate of severity, was calculated for each disease. The percentage of fields affected was calculated for an estimate of prevalence.

RESULTS AND COMMENTS: Relatively low levels of disease were found in 1990 (Table 1). Root rot (several fungi) showed levels similar to the last three years. The percentage of fields affected by pasmo (Septoria linicola) was similar to past years, however, the disease index was considerably below the value of 5.0 recorded in 1987. Aster yellows, usually found in trace amounts, was not found this year, nor has rust been found in the last four years.

Table 1. Severity and prevalence of flax diseases in 1990

Crop District	No. fields	Disease index/% fields affected	
		Root rot	Pasmo
5b	6	0/0	0.3/100
8a	13	<0.1/8	0.8/77
8b	8	0/0	0.5/88
9a	8	0.2/13	1.7/88
Total or average	35	<0.1/5	0.8/88

Crop / Culture: Lentil

Location / Emplacement: Manitoba

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Title / Titre: Anthracnose of lentil in Manitoba in 1990

METHOD: Anthracnose of lentil caused by Colletotrichum truncatum was first identified in Manitoba in 1987. Surveys in 1988 and 1989 found that the disease was present in all major areas of lentil production. A survey of the Rosenort/St. Jean area south of Winnipeg and the Portage La Prairie area west of Winnipeg was conducted in Manitoba in the 1990 season. During visits a semi-quantitative assessment of anthracnose was made by walking at least 100m through the crop. A disease severity rating was recorded as none, slight, moderate, or severe by closely examining plants for signs of defoliation, stem and leaf lesions.

RESULTS AND COMMENTS: In the Rosenort/St. Jean area the disease was detected in 23 out of 24 fields surveyed. The disease was slight to moderate in a few fields and severe in most. In the Portage region 12 out of 16 fields visited were infected by C. truncatum. The disease was moderate in most fields, severe in a few and slight in one field.

Samples from a moderately infected commercial faba bean field were collected and determined to be infected with anthracnose. Restricted anthracnose lesions were found on field pea plants grown on infected lentil stubble as part of a disease nursery. Field pea plants from a number of commercial fields were also collected; however, fungal isolations were not successful. Selected isolates from lentil, field pea and faba bean were confirmed by the Biosystematics Research Institute, Ottawa, Canada as Colletotrichum truncatum (Schwein.) Andrus and W.D. Moore.

Anthracnose was observed in fields sown with lentil for the first time as well as in fields where lentil was in a minimum 4-year rotation, indicating that anthracnose can build up rapidly even when lentil is not sown on lentil stubble. Temperature and precipitation appear to have favored the development and progression of the disease until early August. Dry conditions thereafter appeared to inhibit further disease development with many producers still reporting an average to above average yield. Significant yield losses are possible with anthracnose if infected fields receive normal precipitation near the end of the growing season. In 1989 yield losses from anthracnose based on plot results were estimated to be between 40% and 60%.

REFERENCE: R.A.A. Morrall, R.J. Gibson and C.C. Bernier. 1990. Anthracnose of lentil in Manitoba. Can. Plant Dis. Survey.70(1):79.

Crop / Culture: Lentil

Location / Emplacement: Saskatchewan

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Title / Titre: DISCOVERY OF LENTIL ANTHRACNOSE IN SASKATCHEWAN IN 1990

METHODS: Anthracnose of lentil, caused by Colletotrichum truncatum (Schwein.) Andrus & W.D. Moore has been a cause of concern in Manitoba in recent years (2,3,4). On July 13 1990 a lentil crop near Zealandia, Saskatchewan (90 km S.W. of Saskatoon) was found to be infected with the disease. As this was the first report of anthracnose in Canada's largest lentil producing province, a survey was organized.

A message was sent to all extension agrologists employed by Saskatchewan Agriculture, plus several other individuals involved in the lentil industry. These people were invited to check samples of lentil crops in their regions and send plants with suspicious symptoms to our laboratory. When specimens with anthracnose were received, visits were made to the regions where they originated in order to inspect additional crops. Also, lentil crops in some regions were inspected during the course of other work. In regions of extensive lentil cultivation, generally only every fifth lentil crop was inspected. Usually at least a 100 m long pathway through each field was checked for disease. In a few cases several visits were made to the same crop to observe disease progress. When symptoms were uncertain, specimens were brought back to the lab; these were checked microscopically for the presence of setae of C. truncatum, often after incubation in a moist chamber.

In September, after harvest, an article was published in a newsletter mailed to most pulse crop growers in the province. Farmers were invited to send specimens of plant residues and seed from crops that they suspected might have anthracnose. Plant residues were inspected microscopically, as described above. Seed samples were surface-disinfected for 10 min in 0.6% NaOCl, plated on Bacto-Difco potato dextrose agar amended with 25 ppm ampicillin and 25 ppm streptomycin sulphate and incubated at room temperature for 10 days. Seed samples from crops observed to be severely diseased during the field survey were also obtained and plated.

RESULTS AND COMMENTS: Specimens of plants were received from 63 crops between July 20 and August 24 and specimens of plant residues or seed were received from nine crops after harvest. Field inspections were made in 85 crops between July 15 and August 27. The intensity of survey was not proportional to the lentil acreage in different crop districts.

Anthracnose was detected on lentil in several parts of Saskatchewan (Fig. 1, Table 1). Almost all samples received and crops inspected were cv. Laird, which is predominant in Saskatchewan, but the disease was also found on cv. Eston. In the crop where the disease was originally discovered and in several others nearby, disease progressed considerably from mid-July to mid-August when swathing took place. In these and other crops where the disease was severe, anthracnose was not uniformly distributed in the field. Most seed samples which tested positive for anthracnose showed less than 5% infection. However, in one severely diseased crop where multiple samples were collected from different parts of the field, seed infection ranged from 0 to 24%.

The majority of anthracnose-infested crops were either in a triangular area bounded by Wiseton, Bounty and Zealandia (Crop Districts 6B and 7A), near Laird (65 km N of Saskatoon, Crop District 6B) or near Bellevue (85 km N.E. of Saskatoon, Crop District 8B). All three areas are regions where there has been extensive lentil cultivation for at least 15 years. The wide distribution of anthracnose in these and other parts of Saskatchewan suggests that the disease has been present for at least several years. Anecdotal evidence about the effect of severe anthracnose infestation on yields was obtained from three farmers growing cv. Laird. Comparisons were made between severely and less severely diseased areas in the same field, or between severely diseased and relatively healthy crops seeded nearby at the same time. Losses of 12% (1900 vs. 2130 kg/ha), 16% (1900 vs. 2250 kg/ha) and 70% (800 vs. 2700 kg/ha) were suggested. Two farmers reported difficulty swathing severely diseased plants because of lodging.

Ascochyta blight was commonly found in seed and plant samples submitted to the laboratory and in crops inspected in the field, especially in Crop Districts 7B, 8A, 8B and 9A. Although this disease remains a major problem for lentil producers in Saskatchewan (1,5), it did not usually cause severe seed discoloration in 1990 because of dry weather in August. Most lentil growers in Saskatchewan in 1990 harvested a bumper crop of high quality seed.

ACKNOWLEDGEMENTS: The financial assistance of the Saskatchewan Pulse Crop Development Board and the Western Grains Research Foundation is gratefully acknowledged. Technical assistance was provided by Rosanne Beaulé. We appreciate the assistance of Neil Whatley, Bert Vandenberg and a number of extension agrologists and farmers who provided us with samples.

Table 1. Records of anthracnose and ascochyta of lentil in 1990 relative to Saskatchewan crop districts

Saskatchewan Crop District*	No. of plant or seed samples sent to lab			No. of crops inspected in field		
	Total	Infected with anthracnose	Infected with ascochyta	Total	Infected with anthracnose	Infected with ascochyta
1A	1	1	0	-	-	-
2A	1	0	0	-	-	-
2B	4	0	3	-	-	-
3B-N	9	2	3	8	0	7
3B-S	5	0	3	-	-	-
4B	5	0	0	-	-	-
5A	2	0	0	-	-	-
5B	9	0	5	-	-	-
6A	2	0	0	-	-	-
6B	12	2	3	41	19	11
7A	8	1	0	17	3	2
7B	13	0	7	-	-	-
8A	-	-	-	6	0	5
8B	1	0	0	8	3	3
9A	-	-	-	5	0	5

* See Fig. 1 for location of crop districts

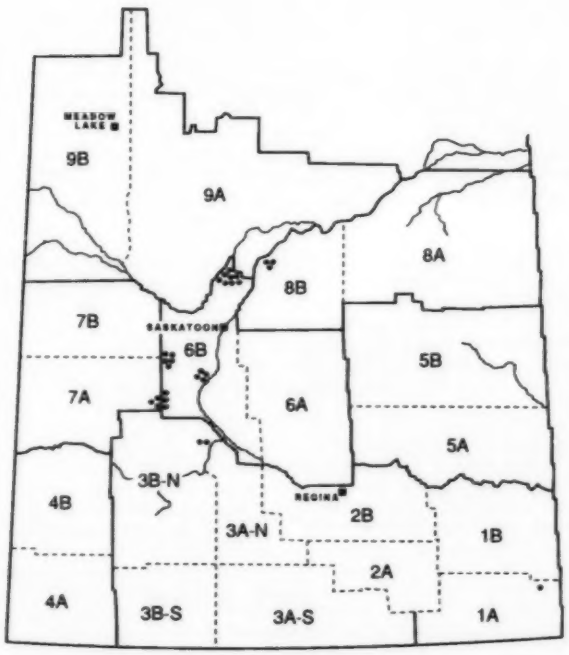

Figure 1. Map of Saskatchewan crop districts showing locations where lentil anthracnose was found in 1990.

REFERENCES

1. Bedi S. and R.A.A. Morrall. 1990. Ascochyta blight in lentil crops and seed samples in Saskatchewan in 1988. Can. Plant Dis. Survey. 70: 123-125.

2. Morrall R.A.A. 1988. A new disease of lentil induced by Colletotrichum truncatum in Manitoba. Plant Dis. 72: 994.

3. Morrall R.A.A., R.J. Gibson and C.C. Bernier. 1990. Anthracnose of lentil in Manitoba in 1989. Can. Plant Dis. Survey 70: 79.

4. Morrall R.A.A., B.D. McCallum and C.C. Bernier. 1989. Anthracnose and other diseases of lentil in Manitoba in 1988. Can. Plant Dis. Survey. 69: 66.

5. Morrall R.A.A. and J.W. Sheppard. 1981. Ascochyta blight of lentils in western Canada: 1978-1980. Can. Plant Dis. Survey 61: 7-13.

Crop / Culture: Field Pea and Field Bean

Location / Emplacement: Manitoba

Title / Titre: Diseases detected on field pea and field bean in southern Manitoba in 1990

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FIELD PEA

Method: Twenty-six fields were examined in 1990. Eight were surveyed on July 5, 9 on July 25, and 9 on July 26. The fields surveyed in southern Manitoba were located: 1) in the area around Portage la Prairie (west of Winnipeg), 2) in the area including Morden, Plum Coulee, Altona and Roland (southwest of Winnipeg), and 3) in the area of Morris, St. Jean and St. Joseph (south of Winnipeg). The survey in each field followed an inverted 'W' pattern beginning approximately 50 m from the edge of the field with 20 m separating the 5 points. Five plants were sampled at each point for a total of 25. Disease diagnosis was based on visible symptoms except for ascochyta leaf and pod spot and anthracnose where the similarity of symptoms necessitated microscopic examination of the foliage or isolation onto agar.

Results: Mycosphaerella blight (*Mycosphaerella pinodes*) was found in 22 of 26 fields (85%), bacterial blight (*Pseudomonas pisi*) in 23 (88%), downy mildew (*Peronospora viciae*) in 16 (62%), leaf blotch (*Septoria pisi*) in 3 (12%), anthracnose (*Colletotrichum* sp.) in 3 (12%), and ascochyta leaf and pod spot (*Ascochyta pisi*) and pea streak virus in one field each (4%).

Comments: The percentage of fields with mycosphaerella blight increased from 50% in early July to 85% in late July while severity varied from trace to moderate. Bacterial blight, however, was more prevalent and severe in early July but severity decreased as a dry period set in. Downy mildew was observed in both survey periods at trace to light levels; in general it was more prevalent and more severe around Portage la Prairie. It was quite common to find mycosphaerella blight, bacterial blight and downy mildew in the same field. Powdery mildew did not develop into a problem in commercial fields in 1990, except in highly susceptible cultivars. It was found in two fields of semi-leafless cultivars, one Radley and the other probably Tipu. Aphids were not a severe problem except in the Portage la Prairie area.

Interesting observations this season were: 1) finding anthracnose in two commercial fields and in research plots near Portage la Prairie and at Morden; severity was light, 2) finding ascochyta leaf and pod spot in a commercial field and in research plots at Morden, and 3) finding septoria leaf blotch in a commercial field. It may be that the recent appearance of anthracnose and ascochyta leaf and pod spot reflects the change in cultivars grown.

In 15 samples of field pea examined at the Manitoba Agriculture Plant Pathology Laboratory, 5 showed mycosphaerella blight (*Mycosphaerella pinodes*), 2 anthracnose (*Colletotrichum* sp.), 6 fusarium root rot (*Fusarium* spp.), 2 environmental stress, and 1 herbicide injury.

FIELD BEAN

Twelve fields were examined in the early part of July. Common blight was present in most fields; it was quite severe in some. As drier weather developed bacterial blight severity dropped drastically.

In 22 samples of field bean examined at the Manitoba Agriculture Plant Pathology Laboratory, 15 showed common blight (*Xanthomonas phaseoli*), 3 fusarium root rot (*Fusarium* spp.) and 4 herbicide injury.

Crop / Culture: Pea

Location / Emplacement: Saskatchewan

Title / Titre: PEA DISEASES IN N.E. SASKATCHEWAN, 1990

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METHODS: Twenty-four fields of pea were surveyed between July 31 and August 14, 1990 in Saskatchewan Agriculture Crop Districts 5b, 8a, 8b and 9a. Fields were sampled by collecting one plant at ten sites located on a diagonal transect. Diseases were identified by symptoms, and the severity of each foliar disease recorded as the estimated percentage area affected of the leaf or stem. Root rot and foot rot were assessed on a scale of 0=healthy, 2=trace, 5=moderate and 10=severe. Results were averaged over total number of samples and fields, and the disease index, an estimate of severity, was calculated for each disease. The percentage of fields affected was calculated for an estimate of prevalence.

RESULTS AND COMMENTS: Disease levels in 1990 were generally lower than the 1987 to 1989 average (Table 1). Severity of mycosphaerella blight (*Mycosphaerella pinodes*) and powdery mildew (*Erysiphe polygoni*) was less than half the average value. Foot rot (*Ascochyta* sp.) was similar to the three year average disease level, but root rot (*Fusarium* spp.) was considerably reduced. Downy mildew (*Peronospora viciae*) was also similar to the average, but ascochyta leaf spot (*Ascochyta pisi*) was not found this year. Sclerotinia stem rot (*Sclerotinia sclerotiorum*) was found at low levels for the first time in four years.

Table 1. Severity and prevalence of pea diseases from 1987 to 1990

Disease	Disease index/% fields affected	
	1990	1987-1989 average
Mycosphaerella blight	5.9/100	12.9/91
Powdery mildew	4.5/17	18.8/69
Foot rot	1.5/75	1.8/76
Root rot	0.1/4	1.5/69
Downy mildew	0.3/8	0.3/9
Ascochyta leaf spot	0.0/0	0.4/28
Sclerotinia stem rot	0.1/4	0.0/0

Crop / Culture: Soybean

Location / Emplacement: Southwestern Quebec

Title / Titre: INCIDENCE OF SOYBEAN DISEASES IN THE ST-HYACINTHE REGION IN 1990

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MATERIALS AND METHODS: A preliminary survey was conducted in 1990 in 11 soybean fields in the St-Hyacinthe region. The purpose of this study was to determine the incidence of the different diseases that could be observed visually walking randomly in each field. Samples of diseased plants were taken to the laboratory for identification of the pathogens that could be isolated on culture media or readily observed on prepared sectioned and stained tissues. After harvest, seed samples were disinfected and plated on selective media to identify the seedborne fungi.

RESULTS AND COMMENTS: The 1990 growing season was characterized by frequent rains in June and towards the end of the season, especially at harvest. These conditions were favorable for disease development throughout the season. Seedling diseases were not observed. Downey mildew (Peronospora manshuria) varied from trace to severe infections. Bacterial pustule (Xanthomonas campestris) was observed in all fields varying from trace to low infections. Bacterial blight (Pseudomonas syringae) was present in some fields with only very low infections. In five fields symptoms of mosaic and mottle were observed in trace amounts but the pathogens were not identified. Several different leaf spots were found in low amounts in most fields and could not be readily identified from symptoms described in the literature. The fungi isolated from these spots are: Ascochyta sp., Phyllosticta sp., Septoria sp., and Alternaria sp.. Physiological diseases such as sunburn injury and ozone pollution were commonly found in low amounts in all the fields surveyed. Stem, pod, and seed diseases were quite common in all fields just before harvest: Fusarium graminearum and F. equisiti were isolated from basal stem cankers of many specimens. Pod and stem blight as well as stem canker (Diaporthe phaseolorum) were present in most fields. Anthraenose caused by both Colletotrichum and Glomerella was commonly observed on affected stems in all fields. Severe infection of plants by Sclerotinia sclerotiorum was observed in one field especially where the soil was not well drained. Pod infection by Fusarium graminearum, Phomopsis sp., and Perenospora manschuria were observed in moderate quantities in all the fields. Seed discoloration ranging from slight and extensive dark spots as well as reddish, purple, and dull white areas were quite common in the harvested grain of all the fields. Table 1 summarizes the percentage diseased seeds from which several fungi were isolated or observed.

Table 1. Percentage diseased soybean seeds from which different fungi were isolated or observed.

Fungi	% Seed discolored or shrivelled				
	Dark	Reddish	Purple	Dull White	Shrivelled
Alternaria sp.	75.0	42.2	-	30.8	38.2
Bipolaris sp.	1.4	-	-	-	-
Botrytis sp.	-	-	-	-	2.9
Cercospora kikuchii	-	-	100.0	-	
Cladosporium sp.	1.4	-	-	-	-
Epicoccum sp.	-	-	-	-	2.9
Fusarium avenaceum	1.4	-	-	-	-
Fusarium anthrophylum	-	-	-	7.7	-
Fusarium equisiti	1.4	-	-	-	-
Fusarium graminearum	19.4	59.7	-	-	14.7
Fusarium moniliforme	1.4	-	-	-	-
Fusarium oxysporum	-	-	-	7.7	-
Fuarium sambucinum	-	-	-	-	2.9
Fusarium sporotrichoides	12.5	36.8	-	23.1	23.5
Sclerotinia sclerotiorum	-	-	-	-	11.8
Peronospora manshuria*	-	-	-	100.0	-
Phomopsis sp.	8.3	5.3	-	15.4	2.9
Verticillium nigrescens	11.1	10.5	-	7.7	-

*Direct observation on seed surface.

Crop / Culture: Sunflower

Location / Emplacement: Manitoba

Title / Titre: SURVEY OF SUNFLOWER DISEASES IN MANITOBA IN 1990

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Methods: A total of 69 sunflower fields were surveyed in southern Manitoba in 1990. Twenty fields were surveyed on July 25, four on July 30, 23 on August 2, 13 on August 21 and 9 on September 6. Fields were selected at random in different regions. Each field was sampled by two persons walking 100 m in opposite directions inside the field following an inverted 'V' pattern. Diseases were identified by symptoms and the incidence of downy mildew, sclerotinia wilt and verticillium wilt were recorded. Disease severity for rust and septoria leaf spot were measured as percent leaf area infected. A disease index was calculated for each disease in every field based on disease incidence and disease severity (Table 1). In addition, 28 samples of sunflower were submitted for analysis to the Manitoba Agriculture Plant Pathology Laboratory by agricultural representatives and growers.

Results: The crop conditions were generally good with a stand range from excellent to good and a vigour range from good to fair. Rust (Puccinia helianthi) was the most common and widespread disease on sunflower. The prevalence and severity of rust observed in 1990 were lower than levels observed in previous years (1). Rust was observed in 68% of the fields surveyed with severity ranging from 1% to 60% leaf area infected. The severity of rust in most fields surveyed in July was in the 1% to 5% range. Fields surveyed towards the end of the season had 20% to 60% leaf area infected.

The prevalence and incidence of verticillium wilt (Verticillium dahliae) were high in 1990. The disease was observed in 60% of the fields surveyed with incidence ranging from 1% to 50% infected plants. The highest disease incidence was in the non-oil sunflower hybrids which are more susceptible to this disease.

The prevalence and incidence of sclerotinia wilt (Sclerotinia sclerotiorum) were low in comparison to those observed in previous years (1). This disease was observed in 57% of fields surveyed with incidence ranging from 1% to 30% infected plants.

Downy mildew (Plasmopara halstedii) was observed at higher levels than in previous years (1). The disease occurred in 30% of the fields surveyed and the disease incidence ranged from 1% to 10% infected plants. However, disease incidence up to 60% was observed in the low spots of some fields where the soil moisture level was probably high at the seedling stage.

Septoria leaf spot (Septoria helianthi) was observed in 22% of the fields surveyed at trace to 1% severity. Traces of stem lesions (Phoma spp. and Phomopsis spp.) were observed in various sunflower fields towards the end of the season. Other diseases such as sclerotinia head rot (S.sclerotiorum), botrytis head rot (Botrytis spp.) or rhizopus head rot (Rhizopus spp.) were not encountered in this survey.

Of the 28 samples submitted to the Manitoba Agriculture Plant Pathology Laboratory, one each showed sclerotinia wilt, downy mildew, rust, verticillium wilt, septoria leaf spot and alternaria leaf spot. Five of the samples showed environmental stress from drought conditions. In addition to diseases, 17 of the samples were found to be affected by herbicide drift.

Table 1. Prevalence and severity of sunflower diseases in southern Manitoba in 1990.

Disease	% of fields infested	Mean of disease index*	Range of disease index
Downy mildew	30%	1.1	1-2
Rust	68%	1.1	1-4
Sclerotinia wilt	57%	1.2	1-3
Verticillium wilt	60%	1.2	1-4
Septoria leaf spot	22%	1.0	1
Stand	-	1.2	1-5
Vigour	-	1.6	1-4

* Disease index is based on a scale of 1 to 5; 1= trace to 5% disease, 2= 5% to 20% disease, 3= 20% to 40% disease, 4= 40% to 60% disease and 5= greater than 60% disease levels. Index is based on disease incidence for downy mildew, sclerotinia wilt and verticillium wilt, and on disease severity measured as percent leaf area infected for rust and septoria leaf spots. Indexes for stand and vigor are based on 1-5 scale (1= very good and 5= very poor).

Reference: 1) Rashid, K. Y. and R. G. Platford, 1990. Survey of sunflower diseases in Manitoba in 1989. Can. plant Dis. Surv. 70 (1): 85-86.

Vegetables / Légumes

Crop / Culture: Potato

Location / Emplacement: Manitoba

Title / Titre: Disease survey of Russet Burbank potato fields in Manitoba in 1990 and results of submissions of potatoes to the Manitoba Agriculture Plant Pathology Laboratory

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Methods: The Manitoba potato growing area was divided into four districts; Winkler, Portage la Prairie/MacGregor, Carberry and other. Seventy-four processing Russet burbank fields were randomly selected to be sampled for early senescence. The number of fields selected from each district was determined by the proportion of the total potato growers in the province, that produced potatoes in that district. In early September, plant samples were submitted to the Manitoba Agriculture Plant Pathology Laboratory for disease analysis. Samples were examined for disease symptoms. Isolations, where required, to verify presence of disease organisms were done using Potato Dextrose Agar and Sorbose Agar.

In addition to the survey there were 52 samples of potatoes submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990 by agricultural representatives and potato growers. Samples were examined for symptoms of disease. Isolations, when necessary, were made on Potato Dextrose Agar and Sorbose Agar.

Results: Results of the potato survey are shown in Table 1. Location of fields sampled is shown in Figure 1. Verticillium wilt (Verticillium dahliae) was found in 30% of fields in the survey. The incidence of verticillium wilt was highest in the Winkler area 61% and was not present in any of the fields sampled in the Carberry area. Black dot (Colletotrichum coccodes) was found in 74% of fields sampled and found at high levels in all areas ranging from 81% of the fields in the Carberry area to 67% in the Winkler area. Fusarium (Fusarium spp.) was found in 46% of the fields sampled, and ranged from 50% in fields classified in the survey as other (mainly located near Carman) to 40% in the Portage la Prairie/MacGregor area. Rhizoctonia (Rhizoctonia solani) was found in 22% of fields surveyed and ranged in incidence from 40% in the Portage la Prairie/MacGregor area to 22% in the Winkler area. The incidence of fields infected with both verticillium and one of the other causes of early senescence was also tabulated. Verticillium was found most commonly in association with black dot (22%) and least often in combination with rhizoctonia (4%). The survey indicated that verticillium and black dot are the major diseases associated with early senescence of potatoes in Manitoba in most regions except in the Carberry area where no verticillium was detected but black dot was present in 81% of fields surveyed. Verticillium was also not detected in potato fields in the Carberry area in a survey conducted in 1989. The high incidence of verticillium (61%) in the Winkler area may be related to crop rotation as this area in past years was a major centre of sunflower production. Sunflowers are also susceptible to verticillium wilt caused by (Verticillium dahliae).

Diseases diagnosed on potato samples submitted to the laboratory in 1990 are presented in Table 2. The most commonly observed disease was early senescence caused by verticillium wilt (Verticillium dahliae) either alone or in combination with black dot (Colletotrichum coccodes) and fusarium wilt (Fusarium spp.). The majority of samples originated from Winkler and Portage la Prairie in south central Manitoba. Drought stress was also a problem in 1990 particularly in the Winkler area. One sample of potatoes was found to have ring rot (Corynebacterium sepedonicum). A subsequent field inspection revealed a level of tuber infection close to 4%. Leak (Pythium spp.), was a problem in 3 samples submitted from the Carberry area and serious losses occurred in storage.

Table 1: Results of Survey of Manitoba Potato Fields [1] For Early Dying Diseases in 1990.

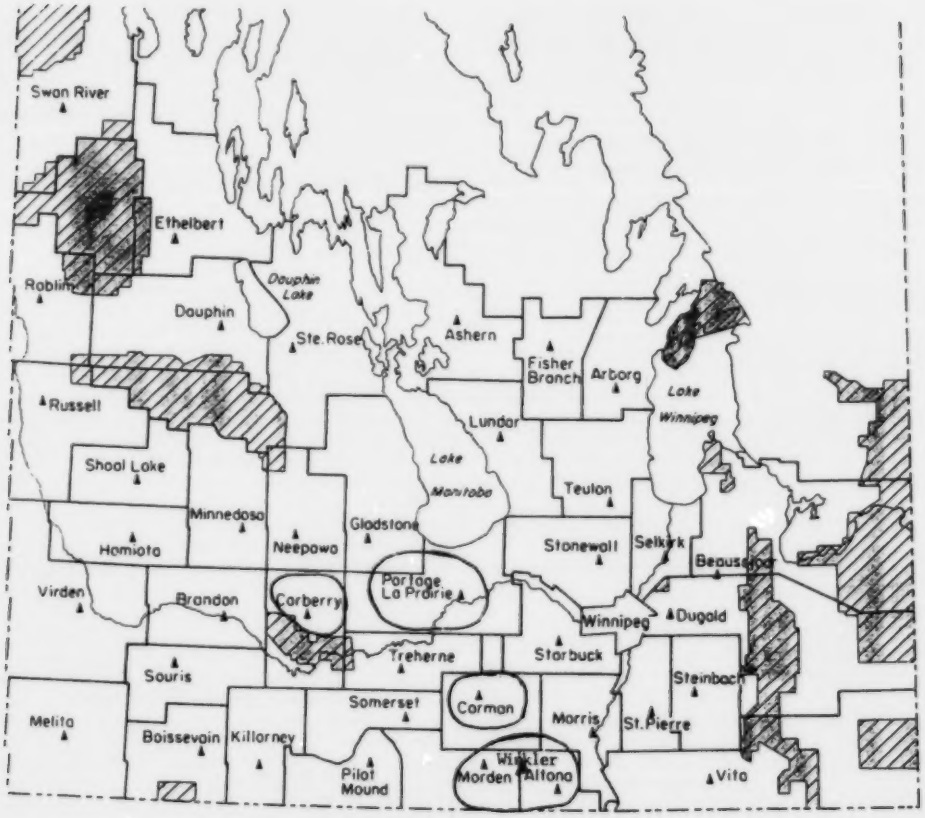
Disease	Percentage of Potato Fields Within 4 Districts Sampled				
	Winkler	Portage la Prairie MacGregor	Carberry	Other	Provincial Average
Verticillium	61	50	0	25	30
Black dot	67	70	81	75	74
Fusarium	44	40	47	50	46
Rhizoctonia	22	40	16	25	24
Verticillium & Black dot	39	40	0	25	22
Verticillium & Fusarium	17	10	0	25	8
Verticillium & Rhizoctonia	6	10	0	0	4
No disease	0	5	16	25	9

% totals do not equal 100% because many of the infected plants had more than one disease.
(1) 74 fields sampled.

Table 2: 1990 Diagnosis of Potato Samples Submitted to the Manitoba Agriculture Plant Pathology Laboratory.[1]

Disease	Scientific Name	Number of Samples
Verticillium wilt	*Verticillium dahliae*	15
Fusarium root rot	*Fusarium* spp.	8
Black dot	*Colletotrichum coccodes*	7
Fusarium wilt	*Fusarium* spp.	5
Fusarium dry rot	*Fusarium* spp.	3
Leak	*Pythium* spp.	3
Common scab	*Streptomyces scabies*	2
Rhizoctonia	*Rhizoctonia solani*	2
Bacterial ring rot	*Corynebacterium sepedonicum*	1
Blackleg	*Erwinia carotovora* pv. *atroseptica*	1
Environmental stress	drought	5
Miscellaneous		2

FIGURE 1: Distribution of the fields for the potato survey in Manitoba in 1990.



= areas surveyed

Crop / Culture: POTATO

Location / Emplacement: Southwestern British Columbia

Name and Agency / Nom et Organisation:
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Title / Titre: A SURVEY OF SILVER SCURF DISEASE (*Helminthosporium solani*) OF POTATOES IN LOWER FRASER VALLEY & PEMBERTON AREA OF B. C.

METHODS: Potato samples were taken at random from storages covering a wide range of cultivars and locations. Each sample consisted of 20-25 tubers. These were examined after washing for visible signs of silver scurf lesions. A few tubers with lesions were selected from each sample and were incubated in humid conditions to enhance conidia formation. Conidia were picked and plated onto a specific antibiotic media. After about 3 weeks incubation, cultures were identified microscopically and the one with *Helminthosporium solani* were considered positive for silver scurf infections. Tubers were rated, based on the level of the surface area covered and the varieties were ranked into very high, high, medium, low, very low and lowest degrees of infection.

RESULTS: The crop harvested in 1989 had high levels of silver scurf infections. There were some cases where disease was observed even at harvest. A total of 90 samples were collected in early 1990 from 21 different cultivars and 27 different storages. Out of 90 samples, 88 had visible signs of infections. Eighty four percent of visible lesions were confirmed to be *Helminthosporium solani* in plate culture tests. Level of infection differed from one cultivar to another and from one storage to another. Some highly infested cultivars were: Chieftain, Red Pontiac, Norchip, Red Gold, Red La Soda and Warba. Cultivars with low levels of infections were: Yukon, Shepody, Norking and White Rose. Among all the cultivars sampled, Redsen had the lowest level of infection.

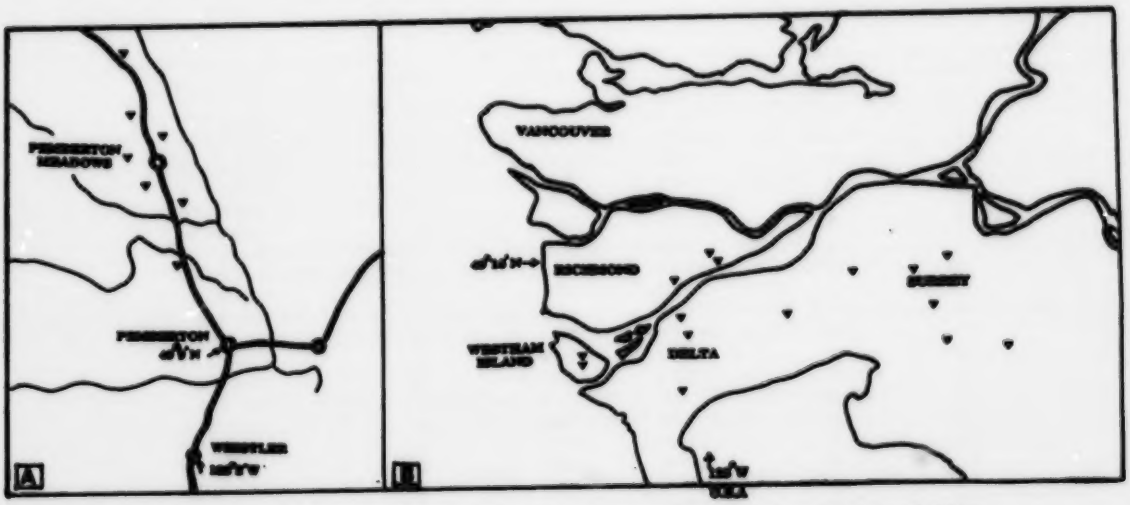

Fig. 1. Maps of locations of potatoes sampled. A. Pemberton Area, B. Lower Fraser Valley.

Crop / Culture: Tomato

Location / Emplacement: British Columbia

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Title / Titre: Infestation of tomato seed by Fusarium oxysporum f. sp. radicis-lycopersici.

Materials and Methods: Seed samples of tomato varieties grown in greenhouses in British Columbia (1989 and 1990) and Alberta (1990) were obtained from commercial seed houses or growers after the seeding of their spring crop. A maximum of 100 seeds per sample were placed on Fusarium selective medium (Komada 1975) and incubated in the dark at 20°C. Colonies that grew from the seeds on the selective medium were transferred to water agar and identified as F. oxysporum f. sp. radicis-lycopersici Jarvis and Shoemaker using the seedling test of Sanchez et al. (1975).

Results and Comments: The results of the seed survey are presented in Table 1. Two of the seed lots were found to be infested with F. oxysporum f. sp. radicis-lycopersici, and only one of the seed lots had a high level of infestation (19%). None of the seed lots from the commercial seed houses were infested with the pathogen. Nevertheless, the finding that tomato seed may be infested with this pathogen suggests that this may be one manner in which the pathogen spreads over short or long distances.

References: Komada, H. 1975. Development of a selective medium for quantitative isolation of Fusarium oxysporum from natural soil. Rev. Plant Prot. Res. (Tokoyo) 8:114-125.

Sanchez, L.E., Endo, R.M., and Leary, J.V. 1975. A rapid technique for identifying the clones of Fusarium oxysporum f. sp. lycopersici causing crown-and root-rot of tomato. Phytopathology 65:726-727.

Table 1. The percentage of tomato seed infested with Fusarium oxysporum f. sp. radicis-lycopersici.

Seed lot	Grower number	Sample year	n	Percent infested	Cultivar
1	1	1989	100	19	Dombito
2	2	1989	100	0	Dombito
3	3	1989	100	0	Dombito
4	4	1989	100	0	Dombito
5	5	1989	100	0	Dombito
6	6	1989	100	0	Caruso
7	6	1989	100	1	Dombito
8	7	1989	100	0	Dombito
9	7	1989	100	0	Caruso
10	8	1989	100	0	Marone
11	8	1989	100	0	82W186
12	8	1989	100	0	Larma *
13	8	1989	100	0	79W175
14	8	1989	100	0	Perfecto
15	8	1989	100	0	Carmelo
16	8	1989	100	0	Dombito
17	9	1990	100	0	Trend *
18	9	1990	100	0	B82-864 *
19	9	1990	43	0	1602 *
20	9	1990	100	0	Dombito
21	3	1990	100	0	Dombito
22	10	1990	100	0	Dombito
23	11	1990	100	0	Larma *
24	12	1990	100	0	Perfecto
25	13	1990	100	0	Vendor
27	14	1990	100	0	Belmondo *
28	14	1990	100	0	Dombito

* F. oxysporum f. sp. radicis-lycopersici resistant cultivar

Tree fruits and nuts / Arbres fruitiers et noix

Crop / Culture: Apple

Location / Emplacement: Ontario

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Title / Titre: DISEASE SURVEY OF COMMERCIAL APPLE ORCHARDS IN SOUTHERN ONTARIO

METHODS: Fruit harvest assessments were carried out in southern Ontario in 68 different commercial orchards and 4 abandoned orchards. At most sites, McIntosh or Red Delicious were checked, but occasionally Empire, Idared and Spartan were assessed. Fruit were sampled at or just prior to harvest maturity.

From standard sized trees, four trees per orchard were examined. Thirty-three fruit from the top, skirt inside and skirt outside were checked. One extra apple was checked from each tree to bring the sample total to 100 apples per tree. From dwarf sized trees, 50 fruit from each of eight trees were checked.

Exceptions to this sampling procedure were the Essex-Kent area, where 200 fruit per orchard were checked; and in the London area, where 300 apples were examined in one of the orchards.

Observations from abandoned orchards in Durham, Essex-Kent, Norfolk-Brant, and the Georgian Bay area are included for comparison.

Fruit was checked for apple scab (*Venturia inaequalis* (Cke.) Wint.), fly speck (*Leptothyrium pomi* (Mont. and Fr.) Sacc.), sooty blotch (*Gloeodes pomigena* (Schw.)Colby), quince rust (*Gymnosporangium clavipes* Cke., and Pk.), cedar-apple rust(*G. juniperi-virginianae* Schw.), powdery mildew (*Podosphaera leucotricha* (Ell. & Ev.) Salm.) and insect injury. These were reported by area as to the presence or absence of disease or insect injury.

RESULTS AND COMMENTS: The incidence of fly speck and sooty blotch was higher in 1990 than in the past three years. In addition, calyx end rot (causal organism undetermined) was found throughout the province.

The number of Red Delicious fruit infected with quince rust was relatively high in the Northumberland, Hastings, and Prince Edward County area (data not shown). Cedar-apple rust was also relatively more prevalent in this area on cultivars and orchards not included in the harvest assessment data.

The incidence of powdery mildew was very low in Ontario in 1990. Fruit injury from insect pests was, in general, considerably higher than damage from diseases.

ACKNOWLEDGEMENTS: We thank the Horticultural Crop Advisors, Pest Management Advisors and others who collected the data for the apple harvest assessments.

COMPARISON OF DISEASE INCIDENCE AND INSECT DAMAGE IN COMMERCIAL AND ABANDONED ORCHARDS, 1990

Area		Number of Fruit	Percent Fruit Affected			
			Scab	Fly Speck	Sooty Blotch	Calyx End Rot
Ontario (Commercial):		25,100	0.8	0.5	0.08	0.3
Abandoned:	Durham	50	38	82	46	
	Essex-Kent	200	100	0	6.5	
	Norfolk-Brant	198	37.9	69	0	
	Georgian Bay	220	97	16	0	

APPLE HARVEST ASSESSMENT, SOUTHERN ONTARIO, 1990

Area	Number Of Orchards	Number Of Apples	Total Number Of Fruit Affected (Range)[1]						Percent Damage	
			Scab	Fly Speck	Sooty Blotch	Calyx End Rot	Powdery Mildew	Quince Rust	Insect	Disease
Essex-Kent	10	2,000	24(1-9)	0	2(1)	4(1-3)	0	0	7.1	1.3
Woodstock	3	1,200	0	19(5-14)	0	3(3)	0	0	8.4	1.8
London	3	1,100	2(1)	0	12(1-11)	9(1-6)	3(1-2)	0	1.9	2.1
Norfolk-Brant	17	6,800	18(1-6)	60(1-18)	0	22(1-6)	0	0	11.1	1.5
Hamilton-Wentworth	3	1,200	15(15)	16(4-12)	6(6)	0	0	0	15.3	3.1
Niagara	9	3,600	21(1-5)	0	0	0	0	0	3.6	0.6
Georgian Bay	6	2,400	5(1-2)	0	1(1)	0	0	0	12.8	0.2
Durham	5	2,000	94(94)	15(1-12)	0	6(1-5)	0	0	4.5	5.8
Northumberland, Prince Edward, Hastings	7	2,800	5(5)	17(17)	0	24(8-16)	0	17(17)	2.4	2.3
St. Lawrence Valley	5	2,000	17(1-8)	0	0	1(1)	0	0	4.6	0.9

[1]Fruit not necessarily out of grade

APPLE HARVEST ASSESSMENT, SOUTHERN ONTARIO, 1990

Area	Number of Orchards	Number Of Orchards Affected With:					
		Scab	Fly Speck	Sooty Blotch	Calyx End Rot	Powdery Mildew	Quince Rust
Essex-Kent	10	8	0	2	2	0	0
Woodstock	3	0	2	0	1	0	0
London	3	2	0	2	3	2	0
Norfolk-Brant	17	7	10	0	10	0	0
Hamilton-Wentworth	3	1	2	1	0	0	0
Niagara	9	9	0	0	0	0	0
Georgian Bay	6	3	0	1	0	0	0
Durham	5	1	3	0	2	0	0
Northumberland, Prince Edward, Hastings	7	1	1	0	2	0	1
St. Lawrence Valley	5	3	0	0	1	0	0

Crop / Culture: Pears and Junipers

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Location / Emplacement: Lower Fraser Valley and Southern Vancouver Island, British Columbia

Title / Titre: PEAR TRELLIS RUST (Gymnosporangium fuscum) SURVEY IN SOUTH COASTAL BRITISH COLUMBIA

Methods: In order to sell junipers or pear trees outside of the coastal quarantine area, nurseries must be certified free of pear trellis rust. To facilitate this, a survey of pear trees within 1 km or more of each juniper producing nursery is carried out annually. If infections are found on pear, the junipers in the vicinity are checked for infections the following spring when signs of the disease are most evident. Junipers found to be infected are destroyed and replaced by other types of shrubs donated by local nurseries. The inspections are carried out by students who are funded by the sale of certification tags. In 1990, two students carried out the work in the Lower Fraser Valley while another two worked on the Saanich Peninsula of Vancouver Island. The first comprehensive pear survey of the Duncan and Mill Bay areas, just north of the Saanich Peninsula was carried out in one week with additional help from Agriculture Canada, Food Production and Inspection Branch.

Results: Results of the 1990 survey are given in the table below.

Area	Number of Junipers		Number of Pear Trees Examined			
	Examined	Infected	0 - 5 Infections	6 - 50 Infections	50+ Infections	Total
LOWER FRASER VALLEY						
Abbotsford	66	0	63	31	28	122
Bradner	-	-	28	0	2	30
Chilliwack	59	6	83	138	35	256
Hatzic	-	-	126	99	52	277
Mission	-	-	66	151	78	295
Langley	77	0	-	-	-	-
Pitt Meadows	46	0	41	0	0	41
Richmond	864	95	38	11	0	49
Surrey	496	85	47	32	12	91
VANCOUVER ISLAND						
Duncan/Mill Bay	-	-	463	139	68	670
Saanich Peninsula	3062	266	926	885	420	2231
TOTAL FOR 1990	4670	452	1881	1486	695	4062
TOTAL FOR 1989	8368	468	625	1026	855	2506

Comments: As a result of the 1990 pear trellis rust work including the survey reported above, approximately 60 nurseries in the coastal area were certified to sell junipers and pear trees outside the quarantine zone for the 1990/91 shipping season. Approximately 393,000 juniper tags were sold in the 1989/90 season.

Crop / Culture: Sweet Cherry

Location / Emplacement: Okanagan Valley
British Columbia

Title / Titre: LITTLE CHERRY VIRUS DISEASE SURVEY IN THE OKANAGAN VALLEY OF BRITISH COLUMBIA

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METHODS: The annual survey of sweet cherry trees in the Okanagan Valley of British Columbia was conducted between July 4 and July 26, 1990 for symptoms of little cherry disease. One employee of the B.C. Ministry of Agriculture and Fisheries examined orchards in districts with a history of the disease, including the areas around Penticton, Naramata, Summerland, Westbank, Kelowna and Oyama. Approximately 100 properties were visited. Diagnosis of little cherry disease was based on symptoms, including small, often pointed and angular fruit with poor colour and delayed maturity. Following visual diagnosis, tree owners were issued removal notices. Trees with questionable symptoms were indexed at the Agriculture Canada Research Station at Summerland by grafting buds on to indicator trees, including the varieties Sam and Canindex. Leaves of these varieties turn red in late summer of the following year if the disease is present.

RESULTS AND COMMENTS: Forty-seven diseased trees were found in 1990. The table gives a comparison of numbers found in the various districts in recent years:

SUMMARY OF NUMBER OF TREES WITH LITTLE CHERRY DISEASE

Area	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
Oliver	-	0	0	0	0	0	0	0	0	0	5	0	0	2	1
Keremeos	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Penticton	24	32	49	57	21	19	26	39	104	53	49	46	64	184	303
Naramata	1	0	3	0	2	1	6	17	39	20	18	28	84	121	0
Summerland	0	2	2	3	1	4	2	5	4	5	8	4	0	7	0
Kelowna	1	6	8	3	0	0	10	1	0	6	25	22	41	0	0
Westbank	19	1	25	27	0	0	0	0	0	0	0	0	0	0	0
Winfield	-	0	0	0	0	0	0	0	0	0	0	0	4	0	0
Oyama	2	2	14	7	3	7	3	2	5	2	11	7	0	0	0
TOTAL	47	43	101	97	27	31	47	64	152	86	116	109	193	314	304

- unsurveyed

The number of diseased trees identified in 1990 was similar to the number found in 1989, holding the trend of a gradual decline in disease incidence since its peak in 1977. However, low numbers in 1990 could also be partially due to a less intensive survey. Not all areas could be surveyed, and some problem areas such as the city of Penticton have not been thoroughly surveyed for several years. Backyard cherry trees will remain a potential reservoir of disease for nearby orchards until they are cleaned up.

Small fruits / Petits fruits

Crop / Culture: Cranberry

Location / Emplacement: British Columbia

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Title / Titre: CRANBERRY FRUIT ROT SURVEY IN B.C., 1990

METHODS: Thirty-two cranberry bogs from twenty-two farms were sampled at harvest and the percent fruit rot, types of fungi causing the rots and their frequency of occurrence were determined. Samples were taken from the tote boxes as they were delivered to the receiving station.

RESULTS AND COMMENTS: The amount of pre-harvest fruit rot was relatively high, ranging from 19.8% in one Stevens bog to 1.5% in a Ben Lear bog, with an overall average of 7.7%. Average rot for the different cultivars was Crawley 11.0%, Stevens 10.8%, MacFarlane 6.0%, Bergman 4.9%, Ben Lear 4.5% and Pilgrim 3.1%. Viscid rot, caused by the fungus Diaporthe vaccinii, was the most prevalent rot, making up 52% of the total. Early rot, caused by the fungus, Phyllosticta vaccinii, which was the most prevalent in 1989, caused 26% of the total. End rot, caused by Godronia cassandrae, caused only 6% of the rot, unlike 1988 when it was the major cause of both pre-and post-harvest fruit rot. Other minor rots identified were black rot caused by Apostrasseria lunata and Strasseria oxycocci, yellow rot, caused by Botrytis cinerea and Botryosphaeria fruit rot, caused by Botryosphaeria vaccinii. Viscid rot was the main fruit rot in 1987. Blotch rot, caused by Acanthorhynchus vaccinii, which has been reported as causing a storage rot in the eastern U.S., was not found in berries sampled at the receiving station, but was found sporulating on berries in the field.

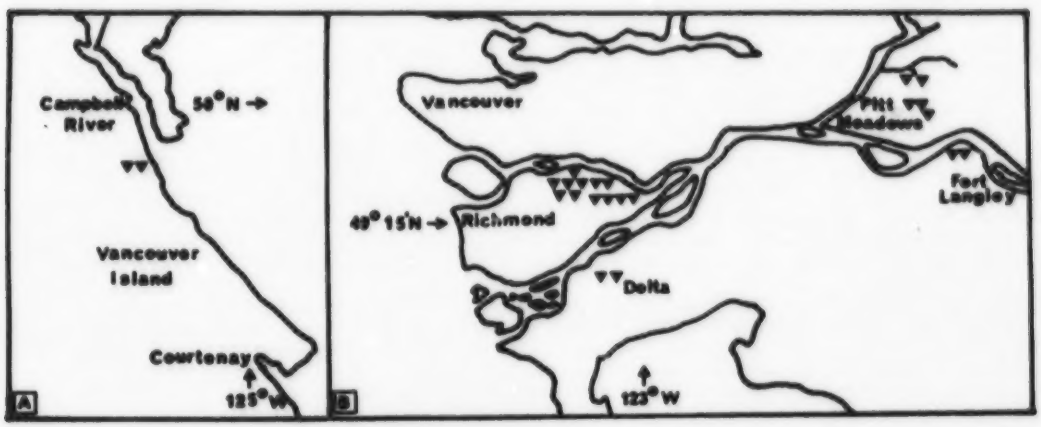

Fig. 1. Maps of locations of cranberry bogs sampled. A, Vancouver Island. B, Lower Fraser Valley.

Crop / Culture: Cranberry

Location / Emplacement: British Columbia

Title / Titre: CRANBERRY TWIG BLIGHT SURVEY IN B.C., 1990

Name and Agency / Nom et Organisation:

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METHODS: Thirty-two cranberry bogs from eleven farms were surveyed in June for twig blight incidence and causal agents determined. Percent disease was estimated by throwing thirty cm squares at random in 10 different locations per bog. Total uprights and diseased uprights were counted and averaged.

RESULTS AND COMMENTS: Percent disease ranged from 3.3.% to .1% in thirty of the bogs. The other two bogs were significantly more diseased being 7.1% and 20.2%, respectively. Cultivar did not affect disease incidence. Diaporthe vaccinii was the main cause of twig blight (ca 99%) with a few twig deaths being caused by Lophodermium hypophyllum.

Crop / Culture: Saskatoon

Location / Emplacement: Alberta

Title / Titre: EPIDEMIC OF ENTOMOSPORIUM BERRY AND LEAF SPOT OF SASKATOONS THROUGHOUT ALBERTA IN 1990

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METHODS: Samples from 19 commercial and 4 domestic saskatoon orchards throughout Alberta were collected or submitted. Collection dates ranged from June 15 to August 5th, 1990. Samples ranged from diagnostic specimens only to systematic sampling of 10% of the bushes. The systematic survey of 5 orchards in central Alberta is reported in detail separately by Pesic-Van Esbroeck, Bains and Motta: only the totals are used here so as to provide an Alberta-wide summary. Fourteen of the orchards were examined by one or more of the authors. In 2 orchards samples were taken in association with spray trials. Sampled orchards ranged from near Calgary to Manning in the northern Peace River region.

RESULTS: Disease incidence was 100% of bushes at all locations examined. Leaf incidence varied from about 30% to 100%. The lower levels were at the younger orchards and/or the drier, more exposed sites. Petiole lesions occurred in all substantial samples, ranging from trace to 100%, and appeared to be the main cause of defoliation, although severely blighted leaves also dropped. Defoliation was present at all sites examined, ranging from trace to quite severe. Complete defoliation of volunteer seedlings was noted at 3 orchards. No resistant commercial cultivars were noted this year. In 1988 some differences were recorded between progeny at Beaverlodge Research Station of Agriculture Canada.

Berry spot incidence was 100% of bearing-age orchards examined. In most cases, it was also 100% of the bushes; and for berries it ranged from trace to 100%. Spots occurred on rachises, pedicels and berries. The number of spots/berry ranged from 0 to 11, but only one spot was required to spoil a berry. Lesions on pedicels and rachises were evident as early as June 15th, and often resulted in fruit drop. At 2 orchards, one between Red Deer and Calgary and the other west of Grande Prairie near the B.C. border, essentially 100% of the fruit dropped prior to ripening (N.B. Over-ripe saskatoons do not drop, they shrivel on). At others, from about 5 to 100% of ripe fruit was marked at harvest. At the Peace Country Fruit Producers' Cooperative processing plant, marked fruit was downgraded from fresh or fresh frozen grades to the processing-only grade. Fruit lots with more than 10% marked berries were downgraded as a whole because that was too many to separate. Observations indicate that the disease was just as prevalent in the British Columbia portion of the Peace River region, but no samples were taken.

It occurred on cultivated saskatoon bushes from 1 to at least 43 years of age. There was no correlation observed between age and disease severity except insofar as age affected density bushes. Increased bush and/or row density increased severity, but appeared less important than site factors: the more sheltered the site, the more severe the disease, presumably because of greater humidity and less evaporation. The oldest row samples was one of the least affected because it was also quite exposed to wind: it had a bumper crop.

COMMENTS: This is the first report in CPDS of Entomosporium spot, caused by *Entomosporium mespili* (DC ex Duby) Sacc., on saskatoon berries, but it has been reported elsewhere recently (1,2,3,4). As a problem on cultivated saskatoons, it was first found in nursery beds at PFRA, Indian Head, Sask., in 1980, where it caused severe defoliation (2). In 1981, the senior author conducted an informal survey of orchards and wild stands from Ft. Vermilion, AB, to Edmonton, and found the leaf spot and blight phases at all locations examined (2). The leaf spot and blight phases have been widely found in North America and are reported in host-range publications. There is some evidence that Entomosporium blight is a range-limiting disease for saskatoons in the humid midwestern states (1). It was noted this year at 2 locations that where the lower foliage of bushes had been pruned, there was much less disease despite heavily infected neighboring plants (2,3). This may offer a means of practical reduction of this disease.

Berries with spots were collected at several locations in Grande Prairie county in 1984 at harvest by which time all samples were heavily contaminated by secondary fungi. Berry spot was not collected again until 1988 when it caused significant economic loss at the Sexsmith Test Orchard (STO), near Grande Prairie, by marking enough berries (about 20%) that the whole crop was dovngraded to processing grade, although there was little loss of yield. In 1988 the berry spots were correctly diagnosed and reported for the first time (1). It caused much smaller losses at the other, mostly young, orchards in the same county. In 1989, it caused similar % losses at STO, but there was little actual crop because of severe frost at flowering, and none was harvested. At STO there has been significant loss of grade due to Entomosporium, therefore, for 3 years in a row; but in the third year, 1990, there was also a loss of yield, with about half the berries unusable.

Entomosporium spot is evidently very weather dependant and requires both high humidity and warmth. In 1990, the exceptionally wet weather in late May - early June throughout Alberta was also warm enough to bring on this disease and enable it to cause its first province-wide epidemic on cultivated saskatoons.

This disease was also universally present in the wild, and caused serious losses with some areas reporting no ripefruit despite a good fruit set.

E. mespili occurs wherever saskatoons are cultivated in the Canadian prairies. Disease incidence on established bushes is probably 100% every year, and likewise in the wild. Usually it has stayed on the lower parts of the bush, only moving up to a significant degree as a result of both warm and humid conditions. Inoculum build-up appears to have occurred over the last 3 or 4 years throughout Alberta, and is certainly at an exceptionally high level now, posing a very serious threat to the newly developing commercial saskatoon industry.

REFERENCES: 1. Davidson, J.G.N. 1989. Saskatoon berry spot. Fruit Grower 5(2): 6-7.
2. Davidson, J.G.N. 1990. Entomosporium leaf and berry spot of saskatoons (Abstr.) Proc. Plant Pathol. Soc. Alberta. 11: (in press).
3. Davidson, J.G.N. 1990. Entomosporium leaf and berry spot of saskatoons in Alberta 1990. Fruit Grower: (in press).
4. Pesic-Van Esbroeck, Z. and P. Bains. 1990. Study of common leaf spot, blight and berry spot of saskatoon caused by **Entomosporium mespili**. (Abstr.) Proc. Plant Pathol. Soc. Alberta 11: (in press).

Crop/Culture: Saskatoon, *Amelanchier alnifolia* (NUTT)

Location/Emplacement: Central Alberta

Title/Titre: SURVEY FOR COMMON LEAF SPOT, BLIGHT AND BERRY SPOT OF SASKATOON IN CENTRAL ALBERTA

Name and Agency/ Nom et Organisation:

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Methods: Saskatoon is becoming a commercially important fruit crop in Alberta. There are approximately 700 acres of saskatoon in Alberta and out of these, 125 are of producing age (1). A survey was conducted to determine the incidence and severity of common leaf spot, blight and berry spot of saskatoon caused by *Entomosporium mespili* (DC ex Duby) Sacc. Five orchards in central Alberta were surveyed in the summer of 1990. Depending upon the size of the orchard, 5 - 10% of saskatoon bushes were examined. A total of 100 leaves and 20 racemes with berries were collected at random from the top, middle and bottom of each bush. Berries were collected from commercially producing orchards only. Disease severity was rated numerically according to the number of leaves and berries per bush affected: 0 - no disease; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%. Random samples of leaves and berries from each site were used for isolation and identification of the pathogen.

RESULTS AND COMMENTS: See table 1. The incidence of common leaf spot, blight and berry spot was 100% in all orchards surveyed.
The symptoms of the disease ranged from a few spots to a severe blight followed by an early by an early defoliation, in some cases as early as the middle of August. Racemes with 100% of the berries infected were frequently observed. Berry infections first observed in early July caused shrivelling, disfiguration, discoloration, cracking and the abundant presence of conidia on the berry surface. Isolations from infected leaves and berries and microscopic examination of the organism revealed the presence of hyaline, 4-celled conidia of *E. mespili*.

Table 1. Incidence and severity of common leaf spot, blight and berry spot of Saskatoon in central Alberta in 1990.

Orchard No.	No. of bushes surveyed	Incidents (%)	Severity (% of leaves and berries infected per category) 0		1		2		3		4	
			B	L	B	L	B	L	B	L	B	L
1	23	100	0	0	0	0	0	0	13	0	87	100
2	27	100	0	0	18	4	26	11	30	48	26	37
3	108	100	*	0	-	22	-	42	-	19	-	17
4	97	100	-	0	-	0	-	0	-	4	-	96
5	25	100	-	0	-	20	-	28	-	32	-	20

+ Disease severity rating: 0=no disease; 1-1-25%; 2=26-50%; 3=51-75%; 4-76-100%.
B and L represent berries and leaves, respectively.
* Berries were not available.

REFERENCES:

1. Hausher, L. 1990. Personal Communication. Alberta Special Crops and Horticulture Research Station, Brooks, Alberta.

Turfgrass / Gazon

Crop / Culture: Turfgrass

Location / Emplacement: Manitoba

Name and Agency / Nom et Organisation: Platford, R.G.
Manitoba Agriculture
Plant Pathology Laboratory
Agricultural Services Complex
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WINNIPEG, Manitoba
R3T 5S6

Title / Titre: Diseases diagnosed on turfgrass, submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1990.

METHODS: There were 95 samples of turfgrass submitted for diagnosis to the Manitoba Agriculture Plant Pathology Laboratory in 1990. Samples were examined for disease symptoms and where necessary isolations were made onto Potato Dextrose Agar (PDA) for indentification of the causal fungus.

RESULTS: The results of the laboratory diagnoses are presented in Table 1. Leaf diseases caused by anthracnose, ascochyta and melting out were more prominent in Manitoba in 1990 than in 1989 primarily as a result of moist weather in June. Snow mold was not a major problem in 1990. Decline of lawns, attributed to Fusarium patch and late season drought conditions, was a frequent problem in 1990 in lawn samples submitted from Winnipeg.

TABLE 1

Lawn and Turf - 95 samples

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Anthracnose	*Colletotrichum graminicola*	25
Leaf blight	*Ascochyta* spp.	8
Melting out	*Drechslera* spp.	27
Fusarium patch	*Fusarium* spp.	11
Leaf spot	*Septoria* spp.	3
Pink snow mold	*Gerlachia nivalis*	2
Slime mold	*Physarum* spp.	2
Environmental stress	drought	6
Herbicide injury		4
Miscellaneous		6

Crop / Culture: Turf Grasses

Location / Emplacement: Saskatchewan

Name and Agency / Nom et Organisation:

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Title / Titre: DISEASE SURVEYS OF GOLF COURSES IN 1990

METHODS: Twenty-five golf courses from Waskesiu in the north to Regina in the south were visited between 03 April and 23 April 1990. Identification of the cause of injury was based on symptoms. Occasionally samples were taken and disease identification was confirmed by isolation of the pathogen.

RESULTS AND COMMENTS: Pink snow mold (Microdochium nivale) and cottony snow mold (Coprinus psychromorbidus) in the LTB and SLTB phases were the winter diseases most frequently seen. Pink snow mold was ubiquitous and sometimes severe (>50% area infected) on Agrostis stolonifera and Poa annua turf of greens and collars, especially on northern courses, and could also be found on P. pratensis fairways. C. psychromorbidus, LTB phase, was severe (>50%) on surrounds to greens at Melfort, Saskatoon and Regina and on some lawns in Prince Albert. Generally, cottony snow mold was found in trace (<1%) to moderate (20%) amounts on fairways and in snow drift areas.

Small areas of turf damaged by snow scald (Sclerotinia borealis) were noted on two courses and grey snow mold damage (Typhula ishikariensis) was found on two northern courses.

Severe pink snow mold (>90%) developed on experimental plots of bentgrass at Saskatoon which had been snow fenced to retain snow cover. Some P. pratensis plots inoculated in October 1989 with sclerotia of Typhula spp. developed very severe injury (>85%).

In early May, desiccation injury was moderately severe to very severe on bentgrass greens in several locations, especially on a course at Prince Albert. At Meadow Lake, desiccation injury was related to very poor rooting, to strips of uneven fertilizer application in the previous year and, on one green, to black plug layer (the result of anaerobic soil conditions). Ice injury, probably resulting from rain in early December, was apparent on a Saskatoon course. Only two new cases of black plug layer were found. One course in southern Saskatchewan was damaged by a herbicide (atrazine) contaminant of a specialized fertilizer. Severe elk urine and feces scorch was noted on fairways of the Waskesiu golf course.

On a new course in Regina, linear patches of low grade root infection with Pythium spp., chytridiaceous fungi, Phialophora spp. and Rhizoctonia spp. was associated with compaction of backfill over drains and excessive irrigation in very hot weather in August.

Fusarium patch (M. nivale) was first noted on 19 September 1990 on plots of Agrostis spp. By 2 October, 14 of 60 plots were affected, but the highest level of infection observed was 2%.

Crop / Culture: TURFGRASS

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B.C. Ministry of Agriculture and Fisheries, 17720 - 57 Ave. Surrey, B.C. V3S 4P9

Location / Emplacement: British Columbia

Title / Titre: TURFGRASS DISEASES DIAGNOSED AT THE B.C. MINISTRY OF AGRICULTURE AND FISHERIES PLANT DIAGNOSTIC LABORATORY IN 1990

METHODS: This summary is based on 95 turfgrass submissions received at the B.C. Ministry of Agriculture and Fisheries Plant Diagnostic Lab at Surrey, B.C. during the first ten months of 1990. Most samples were brought in by golf course greenskeepers, sod growers, or turf maintenance firms. Some were collected during field investigations by the authors. No home lawn submissions from the general public are included as the lab deals only with commercial operations.

RESULTS: The results of the diagnostic investigations are summarized in the following table.

DISEASE	PATHOGEN	MAIN HOST	NUMBER OF SUBMISSIONS	GEOGRAPHIC LOCATION
Take-all patch	Gaeumannomyces	bentgrass	12	South Coast
Necrotic ringspot	Leptosphaeria	Ky. bluegrass	9	Okanagan
Root rot	Pythium	bentgrass	8	South Coast
Pythium blight	Pythium	annual bluegrass, bentgrass	8	South Coast
Melting out	Curvularia, Drechslera	bentgrass, mixed species	7	South Coast
Anthracnose	Colletotrichum	mixed species	6	South Coast
Leaf blight	Ascochyta	mixed species	6	South Coast
Brown patch	Rhizoctonia	bentgrass, mixed species	5	South Coast
Rust	Puccinia	Ky. bluegrass, ryegrass	5	South Coast Kootenay
Pink snow mould	Microdochium	bentgrass	3	South Coast
Red thread	Laetisaria	fescue, ryegrass	3	South Coast
Grey snow mould	Typhula	Ky. bluegrass	1	Okanagan
Slime mould	-	-	1	South Coast
Algae	-	-	1	South Coast
Sooty mould	-	-	1	South Coast
Physiological	thatch/overwatering/etc.	-	16	South Coast
Insect damage	-	-	2	South Coast

COMMENTS: In the south coastal region, Take-all patch caused by Gaeumannomyces graminis var. avenae was the predominant disease on sand-based golf greens of Penncross bentgrass. Root rot and blight caused by Pythium spp. also commonly occurred at the coast and was favored by unusually high rainfall in June and by daily sprinkler irrigation during warm weather in July and August.

Necrotic ringspot caused by Leptosphaeria korrae was widespread on bluegrass lawns in Kelowna and Vernon and appeared to be encouraged by daily sprinkling with automated irrigation systems.

Red Thread (Laetisaria fuciformis) is much more common than this compilation indicates. Most turf managers recognize it and therefore do not submit samples for identification.

Forest trees / Arbres forestiers

Crop / Culture: Conifer forest

Location / Emplacement: Central British Columbia

Title / Titre: Armillaria root disease survey at Williams Lake, B.C.

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Cariboo Forest Region
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METHODS:

A survey for armillaria root disease (pathogen: Armillaria ostoyae) was conducted in a 100 ha forest stand of Douglas-fir at Pinnell Creek, 30 km north of Williams Lake. Part of the area was unlogged, part was selectively logged 35 years ago, and part was selectively harvested 10 years ago. A trial of operational root disease control treatments was planned for the area.

The unlogged portion and the portion selectively logged approximately 35 years ago, were surveyed using standard operational timber cruising procedures to obtain volumes of standing trees. Occurrence of root disease was surveyed using traverse lines spaced 100 m apart.

RESULTS AND COMMENTS:

Armillaria root disease was found on 66 ha of the 106 ha surveyed, in both the logged and unlogged portions of the area. No other root disease was found.

In the area logged 10 years ago, 2 to 3% of the total number of the lodgepole pine saplings exhibited root disease symptoms, in infection centers (single or small groups of infected stems) often less than 10 m apart.

In the area selectively logged 35 years ago, disease spread was apparent from infected Douglas-fir stumps into the surrounding immature lodgepole pine trees. Scattered residual Douglas-fir trees were also infected. Approximately 1% of the stems in the stand showed symptoms or signs of armillaria root disease infection. However, infection was more apparent than in the recently logged area, with 45 to 50% tree mortality occurring in small areas of 0.5 ha or less.the area.

Approximately one half of the unlogged area was infected with armillaria root disease. Areas infected were readily apparent with trees of all ages showing symptoms of infection. It was estimated that 35 to 50% of the original volume in the stand was lost from root disease induced mortality, resulting in extensive infection centers. Individual infection centers were more difficult to detect here than in the other parts of the area because the centers had merged to form large infected areas. Often, within this stand, the distance between consecutive infected trees or groups of trees was 15 m or less.

Mountain pine beetle (Dendroctonus ponderosae) and Douglas-fir bark beetle (D. pseudotsugae) were associated with armillaria root disease-infected trees. In areas where trees were not affected by root disease, only scattered, old mountain pine beetle attack was noted.

Crop / Culture: Douglas fir plantation

Location / Emplacement: Central Interior British Columbia

Title / Titre: Three-year spread of armillaria root disease in a Cariboo Forest Region Douglas-fir plantation.

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METHODS:

In August 1987, a 5.3 hectare portion of a Douglas-fir plantation established in 1973 in the interior cedar-hemlock(ICHe2) biogeoclimatic subzone in the Horsefly Forest District was surveyed by tallying and assessing all planted Douglas-fir on a 10 x 10 m grid. Symptoms and signs of armillaria root disease were recorded for all Douglas-fir showing root disease crown symptoms.

In August 1990, all trees in the infected portion of the stand in a 2.16 hectare subplot were stem mapped and assessed to determine the rate of spread of the root disease.

RESULTS AND DISCUSSION:

A 2.38 ha portion of the plot on the east side of the road that bisected the area had armillaria root diseased-trees. In 1987, stocking was 1095 stems per hectare (sph) in the uninfected portion, and 782 healthy sph in the infected portion. Eleven per cent of the trees were infected with armillaria root disease.

In 1990, the incidence of armillaria root disease had increased from 11 to 16%, the proportion of plot area occupied by infected trees had increased from 56 to 64%, and stocking in the infected portion of the plot had decreased from 782 to 682 sph. The infected portion of the plot is now designated "not-satisfactorily-restocked(NSR)" because it has less than 700 stems per hectare.

The number and distribution of infection centers were also important. There were approximately 20 infected trees per centre (range 1 to 47). Some centers were beginning to coalesce, while others were still forming. Other centers had no trees in them and were not mapped. Armillaria was detected in some centers without trees based on affected vegetation such as false box. Apparently spread of the root disease is still occurring primarily from Douglas-fir stumps to young regeneration trees, mostly lodgepole pine. The next phase will be spread from tree to tree within the existing regeneration. Presently it is too early to assess the tree-to-tree expansion rates of centers.

Because root disease centers were evenly distributed, all healthy trees were no more than 15 m distance from an infected tree, and most were within 5 to 10m distance. If the fungus spreads along roots or through soil by means of rhizomorphs at a rate of 20 cm per year, we expect that within the next 25 to 30 years, most trees could be infected or dead.

In the surveyed area, the time from expression of root disease symptoms to death of an infected tree was usually one year. Therefore, based on the incidence of symptomatic and dead, infected trees, the annual rate of tree mortality caused by the root disease was 2%.

Crop / Culture: Elm

Location / Emplacement: Saskatchewan

Title / Titre: First Record of Dutch Elm Disease in Saskatchewan

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In early August, 1990 two American elm (Ulmus americana) samples from Woodlawn Regional Park, south of Estevan, were found to be infected with Dutch Elm Disease (DED). Subsequent sampling in the area by Saskatchewan Parks and Renewable Resources personnel resulted in 48 additional American elm samples being submitted to the Crop Protection Laboratory. Ophiostoma ulmi (Ceratocystis ulmi) was isolated from 40 of the total 50 samples received from the park area. Thirty-three of the 40 samples with DED came from trees within the park boundary, five from locations within elm shelterbelts just west of the park and two from locations up to 4 km east of the park. This is the first report of DED from Saskatchewan, except for an isolated tree in Regina in 1981 which was immediately felled and burned.

The elm within the park are part of a natural stand which extends along the Souris River Valley. Dead elm wood is abundant along the valley and within the park and many of the trees are in poor health, suffering from old age and drought. Consequently 3000 elm trees within the park have been marked for removal in efforts to prevent further spread of the disease. Cutting and burning of the 3000 designated trees has begun and completion is expected by March, 1991.

No isolates of O. ulmi were detected from elm samples received in 1990 from the cities of Estevan, Regina and Saskatoon as part of an informal survey which has continued for over 10 years in Saskatchewan.

Crop / Culture: Elm

Location / Emplacement: Manitoba

Title / Titre: Incidence of Dutch Elm Disease in Manitoba in 1990

Name and Agency / Nom et Organisation:

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Methods: Results are based on samples of American elm, Ulmus americana and Siberian elm, Ulmus pumila submitted to the Plant Pathology Laboratory from a survey conducted by the Manitoba Department of Natural Resources. Trees were selected for sampling and submission to the laboratory on the basis of presence of wilted brown leaves and internal brown staining at the cambium. All samples submitted were cultured on potato dextrose agar medium and incubated for 7 days at 20°C. Cultures were identified after 7 days of incubation.

Results: There were 2,286 elm trees showing symptoms of leaf wilt and vascular staining sampled in Manitoba in the 1990 survey. Branch samples were submitted to the Manitoba Agriculture Plant Pathology Laboratory for culturing. The results of the survey are presented in Table 1. Tree removals are also included, as this indicates the real impact of Dutch Elm Disease (DED) in the areas sampled. In many areas where DED is prevalent, only a few samples are taken to confirm presence of DED. Surrounding elms with similar symptoms and trees having more than 50% of the crown dead are marked for removal. The sampling results do not give a full indication of the impact of DED in rural Manitoba as sampling and tree removals are concentrated in cities, towns and municipal parks which have a cost sharing agreement with the Manitoba Department of Natural Resources.

Eighty-nine percent (89%) of elms sampled were infected with DED caused by Ophiostoma ulmi (Ceratocystis ulmi). There were 1,097 trees in Winnipeg which were either confirmed in the laboratory as having DED or were highly suspect of being diseased. In addition, 10,105 trees were classified as hazard trees (more than half dead). The 11,202 trees marked for removal in 1990, is almost the same number as marked for removal in 1989 (10,860), or an increase of less than 4%.

There were fewer trees marked for removal in the Brandon (-27%), Interlake (-17%) and Central regions (-21.4%) in 1990. However there was an increase in the trees marked for removal in the Eastern (+390.4%) and Western regions (+44.9%). DED is now almost completely co-existent with the range of native American elm in Manitoba, except for elm trees in the northwest part of the province north of Dauphin. The native range of American elm in Manitoba extends to The Pas. Dothiorella dieback (Dothiorella ulmi) was found in 76 samples of American elm and verticillium wilt (Verticillium spp.) was found in 32 samples of American elm.

In addition to confirming the presence of DED in Manitoba trees, the laboratory confirmed Opthiostoma ulmi (Ceratocystis ulmi) in 2 cultures submitted from Saskatchewan. The infected trees were found near Estevan.

The 1990 results presented in this article differ from previous results submitted in October at the Western Committee on Plant Disease Control conference, as the final totals were not available at that time.

Table 1. INCIDENCE OF DUTCH ELM DISEASE IN MANITOBA IN 1990

AREA	TREES SAMPLED 1989	TREES SAMPLED 1990	TREES DISEASED[a] 1989	TREES DISEASED[a] 1990	% INFECTED 1989	% INFECTED 1990	TREES MARKED FOR REMOVAL 1989	TREES MARKED FOR REMOVAL 1990	PERCENT CHANGE
Winnipeg	1261	1097	1156	979	92	89	10860	11202	+3.2
Brandon	151	129	126	114	80	88	2579	1881	-27.0
Interlake[1]	128	146	103	135	80	92	863	714	-17.3
Central[2]	418	603	346	534	83	89	8932	6023	-21.4
Eastern[3]	32	115	20	88	63	77	429	2004	+390.4
Western[4]	128	50	82	41	64	82	1464	2121	+44.9
Totals	2118	2286	1833	1891	77*	86*	25127	23945	

(a) Based on confirmation of presence of Ophiostoma ulmi (Ceratocystis ulmi) in laboratory cultures

(1) Interlake region includes the City of Selkirk and all area north of Winnipeg between Lake Manitoba and Lake Winnipeg.

(2) Central region includes the town of Portage la Prairie and the area south to the United States border and east to the Red River

(3) Eastern region includes all area east of the Red River to the Ontario border.

(4) Western region includes area west of Portage la Prairie to the Saskatchewan border excluding the City of Brandon

* Figures represent average percent infected in 1989 and 1990

Crop / Culture: Lodgepole pine

Name and Agency / Nom et Organisation: D. Doidge, J. Richmond and J. Muir
B.C. Ministry of Forests
Cariboo Forest Region
540 Borland Street
Williams Lake, British Columbia
V2G 1RB

Location / Emplacement: Central British Columbia

Title / Titre: Incidence of western gall rust and blister rusts on young lodgepole pine in the Cariboo Forest Region.

METHODS:

In 1989, at 31 sites in the Cariboo Forest Region, young lodgepole pine (Pinus contorta var. latifolia) trees were surveyed for incidence of stem rusts (western gall rust Endocronartium harknessii, stalactiform blister rust, Cronartium coleosporiodes, and comandra blister rust, C. comandrae). Plantations of 10 to 20 years age, spaced stands, and natural stands scheduled to be spaced were surveyed.

Within each stand we ran parallel transects at 100 m spacing, and established circular plots (radius 3.99m) at 50 m intervals. All pine trees within the plots were counted and examined.

Where trees were infected with western gall rust, the location on the tree and type of infection were noted. The age of galls was determined by counting the whorls from the top of the tree down to the gall.

Because of the similarity of stalactiform and comandra blister rust cankers, we recorded these rust diseases as "blister rust". For trees infected with blister rust, the position and size of the infected area were recorded.

Incidence (per cent trees infected) was compared per rust, stand treatment, stand density, and biogeoclimatic zone. In planted stands, the age of stem galls was compared to the overall age of the stand to estimate the incidence of gall rust on nursery stock.

The survey was undertaken as a Biology Co-operative Student program between Simon Fraser University and the British Columbia Ministry of Forests.

RESULTS AND COMMENTS:

Incidence of western gall rust was higher in planted stands at 14 per cent (%), than in spaced stands (5.5%), or in natural stands (4.5%). Branch galls were more prevalent in the spaced stands, on 71% of trees, than in planted stands (54%) and in natural stands (52%). These results suggested that incidence of western gall rust increased with decreasing stand density.

Tree mortality associated with stem galls was 8.5% in 11 of the 31 stands surveyed. For all stands, mortality associated with western gall rust was 3.75%. Mortality was greater in natural stands (1.2%) than in planted stands (0.75%). Incidence of gall rust appeared higher in the moister, cooler biogeoclimatic zones than in the very dry to dry zones.

The overall incidence of blister rust was 0.51%. Incidence was highest in spaced stands (0.95%), followed by natural stands (0.47%), and planted stands (0.37%). In contrast to western gall rust, the majority of infections were on the bole . The average length of bole lesions was 24 cm.

Blister rust incidence appeared slightly higher in the dry to moist zones, but did not differ noticeably with differences in stand density.

The higher incidence (14%) of western gall rust in planted stands might be attributed to a variety of factors such as faster growth and more susceptible shoot tissue, or to planting of trees that are genetically more susceptible.

In the spaced, natural stands, gall rust incidence was similar to that in unspaced natural stands, but the fewer stem infections in the spaced stands indicated that the spacing had removed some stem infected trees.

Although stem infection and tree mortality were noticeably greater in natural stands, the effects should be minimal because these stands have more stems per hectare, and losses probably will have little effect on stand yield at harvest time.

The low incidence of blister rust (0.51%) could be attributed to a low occurrence of the alternate hosts, Indian paintbrush (Castilleja spp.) and comandra (Comandra spp.)

Although the levels of blister rust were too low to discern any definite trends, the higher incidence in spaced stands was similar to that reported by previous authors (e.g. van der Kamp and Spence, 1986. Stem diseases of lodgepole pine in the British Columbia interior following juvenile spacing. Forestry Chronicle 63:334-339)

Crop / Culture: Paper birch

Location / Emplacement: Northwestern Ontario

Name and Agency / Nom et Organisation: E. Setliff and J. McLaughlin
School of Forestry
Lakehead University
Thunder Bay, Ontario P7B 5E1

Title / Titre: PRELIMINARY ASSESSMENT OF *CHONDROSTEREUM PURPUREUM* ASSOCIATED WITH POST-LOGGING DECADENCE

METHODS: The site studied was located on the Jack Haggerty Forest near Thunder Bay. The area was harvested of timber except for paper birch (*Betula papyrifera* Marsh.) during the winter of 1986/87. All of the standing birch trees that remained within about a 0.4 ha area were surveyed for the presence of *Chondrostereum purpureum* (Pers.:Fr.)Pouz. basidiocarps in association with logging injuries to the trunks and roots. Increment cores were taken at DBH for subsequent measurement of growth ring widths. A total of 22 stems were examined as solitary trees or as clumps of trees. The wounds ranged in size from about 0.05 m - 0.1 m to 0.2 m - 0.9 m.

RESULTS: The trees were in various stages of decline and many were dead; thus the area represented a classical demonstration of post-logging decadence in birch. Sixteen of a total of 22 trees examined were wounded. *Chondrostereum purpureum* basidiocarps were associated with 75% of the wounded trees. Fruiting mostly occurred at the margins of the wounds; however some fruiting developed through lenticels and sapsucker injuries in the vicinity of the wounds. In one tree, basidiocarps were present at a skidding injury on top of a major root near the root crown. Additional fruiting bodies extended up the trunk from this root. Very little or no callus formation developed around wounds with *C. purpureum* basidiocarps. Substantial callusing was present around wounds in living trees without indications of *C. purpureum* infection. Broken branches and decline symptoms also were noted in the canopies of many birch trees in both the harvested area and in the surrounding forest. Examination of the last five years of growth for each of the trees revealed irregular patterns of growth among the trees. Studies of living trees in the surrounding forest in relation to trees in different stages of decline in the harvested area has yet to be done.

Instructions to authors

Articles and brief notes are published in English or French. Manuscripts (original and one copy) and all correspondence should be addressed to Dr. H.S. Krehm, Research Program Service, Research Branch, Agriculture Canada, Ottawa, Ontario K1A 0C6.

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Titles should be concise and informative providing, with the Abstract, the key words most useful for indexing and information retrieval.

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Figures should be planned to fit, after reduction, one column (maximum 84 × 241 mm) or two columns (maximum 175 × 241 mm), and should be trimmed or marked with crop marks to show only essential features. Figures grouped in a plate should be butt-mounted with no space between them. A duplicate set of unmounted photographs and line drawings is required. Figures should be identified by number, author's name, and abbreviated legend.

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Les articles et les communiqués sont publiés en anglais ou en français. Les manuscrits (l'original et une copie) et toute la correspondance qui s'y rapporte doivent être envoyés à D^r^ H.S. Krehm, Service des programmes de recherche, Direction de la recherche, ministère de l'Agriculture du Canada, Ottawa, (Ontario) K1A 0C6.

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Les tableaux doivent être numérotés en chiffres arabes et avoir un titre concis. Ils ne devraient pas avoir de lignes verticales. Les renvois doivent être identifiés par un signe typographique particulier (* † § # ¶ ** ††) surtout lorsqu'il s'agit de nombres.

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